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Wherever the wind blows:

A comparative analysis of wind power diffusion in the bilateral green certificate system between Norway and Sweden

Ulrika Marie Eriksson

Master's thesis at the Center for Technology, Innovation and Culture (TIK)
Faculty of Social Sciences, University of Oslo

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After 5 years of studies I have reach the end of an era. With this thesis I leave my final mark at the faculty of social sciences. Writing a master's thesis is long and solitary process consisting of highs and lows. I would like to show my gratitude with giving my thanks to several people.

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“As our understanding of the history of technology increases, it becomes clear that a new device merely opens a door; it does not compel one to enter” (White, Lynn jr , 1962).

Abstract

The European Union (EU) has decided to transform the energy sector into renewable energy technologies in order to reduce greenhouse gas emissions. Sweden and Norway have established a bilateral green certificate system to jointly reach the emission targets stated by EU. To encompass different renewable energy sources for electricity in a country's energy system firms need to overcome path-dependency.

This thesis explores in a comparative study how different framework conditions affect the diffusion process of wind power in Norway and Sweden. The functions of technological innovation system approach have been used to unveil what factors induce and hamper the diffusion process. Factors affecting wind power diffusion have been further corroborated by empirical data from interviews of energy companies.

Main findings show that unequal framework conditions generate a higher share of wind power in Sweden than in Norway. The share of wind power in Norway has increased with the establishment of the bilateral green certificate system but the challenges with path-dependency remains. The characteristics of the electricity systems, energy policies, tax regimes, grid capacity and legitimacy are substantial to the diffusion process. The main findings support previous studies done of the bilateral green certificate market by exploring framework conditions. This thesis argues around what measures need to be taken to level out the playing field of wind power investments in Norway.

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Abbreviations and acronyms

CAB -	**The County's Administrative Board**
EC -	**European Commission**
EU -	**European Union**
DES -	**Dominant Energy System**
GWh -	**Gigawatt per hour**
MCE -	**Ministry of Climate and Environment**
MEEC -	**Ministry of Enterprise, Energy and Communications**
MTE -	**Ministry of the Environment**
MoPE -	**Ministry of Petroleum and Energy**
MWh -	**Megawatt per hour**
NOK -	**Norwegian kronor**
NVE -	**Norwegian Water resources and Energy directorate**
RD&D -	**Research, development and demonstration**
RES-E -	**Renewable Energy Sources for Electricity**
RET -	**Renewable Energy Technology**
ROI -	**Return of investment**
SEA -	**Swedish Energy Agency**
SEK -	**Swedish kronor**
TAS -	**Technological Adaptation System**
TFC -	**Total final consumption of electricity**
TGC -	**Tradable Green Certificate**
TIS -	**Technological Innovation System**
TPES -	**Total primary energy supply**
TWh -	**Terawatt per hour**

1 Introduction

Most of the world's energy production is based on fossil fuels. Our stock of oil, coal and gas will, however, not last forever. The extensive use of energy today generates pollution and 80% of EUs total greenhouse gas emissions are energy related (EU, 2011). Europe is importing and consuming increasing volumes of energy and in order to stabilize global warming, greenhouse gas emissions must be reduced. The European Union has set the goal to transform the energy sector into renewable energy sources. By 2020 the EU is aiming to reduce greenhouse gas-emissions by 20 percent (EC, 2014)[1].

The RES-E directive (EC/2001/77) puts relatively strong expectations on member states with respect to implementation of effective support schemes to meet indicative targets and to remove technical, economic and legal barriers to grid access. Alongside the climate challenges the EU wishes to provide secure and affordable energy to member states (and one associated state, Norway). CO_2-gas emissions travel across boarders and it is a must for each country to take their share of the responsibility.

To stimulate increased investments in renewable energy sources for electricity (RES-E) a Tradable Green Certificate (TGC) System has been implemented as an economic support system. Norway has integrated the green certificate market with the one existing in Sweden. The bilateral green certificate market was implemented to increase the share of renewables used for producing electricity. The focus of this thesis is on Norway and Sweden and to analyze comparatively the diffusion of wind power.

It is not always logical why the society has kept some technologies instead of other technologies. To analyze how a transition is made possible to cleaner energy technologies you have to understand what creates lock-in or path dependency (Smith 2011:32). Several articles have debated the importance of the development, use and diffuse of renewable energy technologies (RET) in order to reduce CO_2 emissions and meet climate challenges (e.g. Jacobsson and Bergek 2004, Markard et al. 2012). However, experiences in different countries show that this can be a slow and extended process (Hekkert and Negro, 2009). In Europe, the distributions of renewables differ from country to country and some countries are

[1] [http://ec.europa.eu/clima/policies/brief/eu/index_en.htm] [Retrieved 14.01.2014]

lagging behind whereas some are in the forefront. Many scholars have studied the different ways to accomplish transformation of energy systems, where some countries fail and others succeed (e.g. Garud and Karnøe 2003, Jacobsson and Bergek 2004, Lafferty and Ruud 2008). This opens up a possibility to study how different framework conditions affect diffusion of RETs. I have formulated the following research questions:

(i) How do the framework conditions affect wind power diffusion in Norway and Sweden?

(ii) What are the inducement and blocking mechanisms in the two energy systems?

Energy supply is confronted with many issues such as greenhouse gas emissions, uncertainties related to short-term and long-term security of supply (EIA 2013). The sustainability challenges are strongly intertwined with lock-ins and path dependencies we observe in existing sectors. Over time barriers to change sectors are hard to break down when preferences, expectations and routines become integrated with society (Unruh 2002:317). In addition, established technologies are interwoven with organizational structures, regulations, institutional structures and as a consequence they have a harder time over go change, especially radical changes (Markard et al. 2011:955). With this in mind the choice of using the functions of Technological Innovation Systems approach is considered most appropriate. The theory will be thoroughly explained in the second chapter. It is important to bear in mind that there exist other relevant theoretical approaches which have been used to explain particularities of transitions.

. The first question is answered through a scheme of using the systemic approach to a technology, wind power. This allows me to follow a systematic step-by-step approach to analyze a specific innovation system as a way to identify key policy issues. The second research question will be answered through the systemic analysis thus determining what factors that are inducing or hampering the process of the technology implementation. The qualitative interviews will corroborate the functions approach.

1.1 Background

Norway stands out in comparison to its European neighbouring countries. The Norwegian electricity sector consists of 96,7 % hydropower (NVE 2012). The incentives to generate electricity from additional renewable sources have been absent and Norway has not developed an active policy to create new markets for RETs (Hanson et al. 2011:11). Sweden's electricity system depends on hydropower and nuclear power (SAE 2013). In 2003 the Swedish government implemented tradable green certificates (TGC) to promote the use of RES-Es, to ensure security in electricity supply and to reduce greenhouse gas emissions (MTE, Government bill 2005/06:154)[2]. The way the Norwegian and the Swedish energy systems look like depend on many things, but to point out some things, the different historical paths and previous energy policies have contributed to form the appearances of the systems today.

1.1.1 Wind power installment

If you look at the diagram below you see the numbers of installed capacity in wind power by the end year of 2012 and 2013.

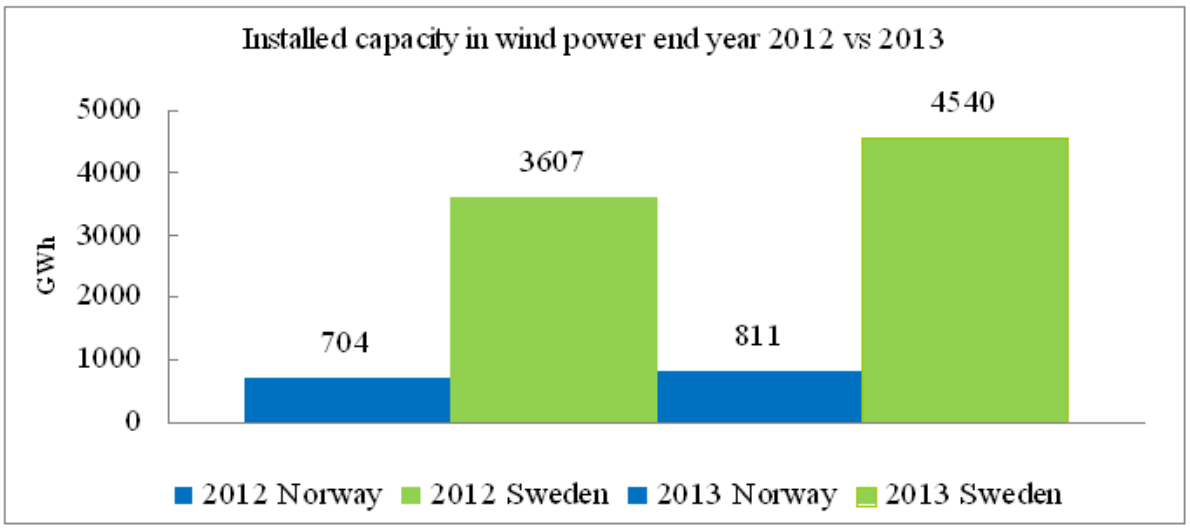

Figure 1. Installed capacity in wind power end of year 2012/ end of year 2013. (Source: NVE/SAE).

[2][http://www.regeringen.se/content/1/c6/06/07/70/d223a994.pdf] [Retrieved 11.02.2014]

The year of 2012 is chosen because that was the year the bilateral green certificate market came into force. The diagram shows the installment of wind power in the following year, 2013, where you see that Norway had an increase of 15%. Sweden had an increase of 25,8%.

Studies have shown there is a great potential for wind power in both Sweden and Norway (e.g. Blindheim 2013, Försund et al. 2008, SAE 2012). The potential for expansion of onshore wind power in Sweden is estimated to be somewhere between 35 TWh and 70 Twh depending on the proximity to settlements (FNI 2010). In 2005 the Norwegian Water Resource and Energy Directorate (NVE) estimated the theoretical potential for onshore wind power in Norway to be 250 TWh (Blindheim 2013:339). The technical potential for onshore wind power in Norway is about 70 TWh but with today's net capacity only 12 TWh feasible (FNI 2010). The greatest potential for wind power in Norway is in the north county, especially Finnmark. The high winds in Finnmark are estimated to over 6m/s. Today most companies consider wind power installment of a minimum of wind speed at 8m/second. The investment costs for wind power on shore lies around 12, 5 millions NOK per MW installed effect. This gives a cost per kWh, including maintenance costs, to between 0,55 to 0,62 NOK for projects with the mean wind speed to 6 and 8 m/s (MoPE, ONR 2012:9)

For wind power is not an issue with the technical aspect when wind turbines that are easily imported. The issue is about how the energy sector can be transformed through the implementation of renewable energy technologies, in my case wind power. For this realization policies have influenced the potential today and will affect the future of the two energy sectors. Both Sweden and Norway are highly dependent on their energy sector with high usage of electricity (IEA 2008, IEA 2013). Actors like firms, organizations and suppliers play a significant part for lobbying and influencing political forces (Jacobsson and Bergek 2004:818). Networks, referred to as important channels for the explicit and tacit knowledge are also important to influence the perception of firms and e.g. guide their future decisions.

On world's basis emissions have to be reduced 50-85% by the year 2050. Today CO_2-gas emissions are estimated to 11 ton per capita in Norway and 5, 6 ton per capita in Sweden (The World Bank[3]). The optimal figure is 1-2 ton per capita (Bellona 2013). To reach this goal measures need to be taken. The change in energy production and energy usage are some of the ways to get there. The energy system needs to be clean and generate electricity from renewables and at the same time, focus on energy efficiency is necessary measures. Over half

[3] [http://data.worldbank.org/indicator/EN.ATM.CO2E.PC] [Retrieved 04.05.2014]

of the total energy usage in Norway is from fossil energy sources. Increased expansion in renewable energy, like wind power, can realize the potential to electrify the oil platforms and reduce the usage of fuel oil in industries and buildings (Bellona 2013). Today's decisions will affect how the energy system will be built up in 2050. Wind power is thus an important contribution for the future prospects on null sum emissions.

1.2 Overview of the thesis

Chapter two presents the theoretical approach that is used to answer research question (i) and (ii). The third chapter presents the research method and the empirical data where I discuss the use of the qualitative approach and the assessment of analyzing interviews and document analysis. The fourth chapter consists of a descriptive context of the Norwegian and Swedish energy systems, policies and historical traits that forms the starting point for the empirical chapter. The fifth chapter is a functions approach that systematically analyses the existing literature and the empirical data through function by function. The sixth chapter is a summary and a discussion of implications and suggestions for future research.

2 Theory

This chapter gives an overview of the theoretical framework that has been used in this study. A functions approach is the main theoretical body. Functions approach is used to gain a comprehensive understanding of the deployment and diffusion of wind power. First a short introduction is given of innovation studies for those unfamiliar to the field. Secondly, the Technological Innovation System is presented and its main elements followed by an explanation of the related functions. The functions have been adapted to a different innovation context, thus a Technological Adaptation System is presented, followed by the modified functions related to this study. Inducement and blocking mechanisms are presented at the end of the chapter.

2.1 Innovation studies and system of innovation

In the 1960's innovation emerged as a field of study. Joseph Schumpeter was a social scientist of the twentieth century that studied economic development as a process of change, driven by innovation. He declared innovation can be thought of as new methods of production, new products, the exploitation of new markets, new ways to organize business and new sources of supply (Fagerberg 2005:6). The process is cumulative and builds on existing knowledge and past innovations while laying ground for new innovative activities, thus innovation is "path dependent". Existing literature analyses innovation with an evolutionary approach linking innovation and adaptation, variety creation and selection (e.g. Fagerberg et al 2009). One important insight that has dominated the field of innovation studies is that innovation is a collective activity. It is stated that the innovation process takes place within the context of a wider system – a system of innovation.

Several dimensions can be used to delineate an innovation system; a country, region, sector or technology, depending on the focus of research (Carlsson et al. 2002:233). I will start by explaining the concept of system of innovation before presenting the technological innovation system approach which will be used in my study.

A system consists of components and the linkages of the different components within the system (Edquist 2005:187). The main function in SIs is to execute innovation processes. Components can be organizations or institutions. Organizations are defined as "formal structures that are consciously created and have an explicit purpose" (Edquist 2005:188). Institutions are sets of norms, rules or laws that regulate the interaction between the components. Institutions can be thought of as "rules of the game" (Edquist 2005:188). The actors or organizations can be defined as the "players of the game".

One of the main advantages with the systemic approach is its focus of innovation through learning. Innovation is a matter of combining existing or new knowledge in new ways thus considering technological change and innovations as something endogenous in the system (Edquist 2005:184). Another advantage with the systemic approach is that is adopts a “holistic” approach. It is holistic in that sense that a whole range of important determinants of innovation are taken into account in an analysis (Edquist 2005:185).

The SI approach has been criticized for conceptual diffuseness and that there are no clear guidelines provided on what should be accounted for in a system thus giving variances in its application. It has also been criticized for not being clear enough providing key issues to policy makers. Edquist (2005) points out that the SI approach is not a formal theory that provides specific propositions regarding casual relations among variables (Edquist 2005:186). There is suggested that more research is done, for example on determinants of an innovation process. It is emphasized that comparative case studies bring great potential to encircle specific determinants within the innovation process (Edquist 2005:201). The critique mentioned above have opened up for developing a scheme of analysis that makes it possible to unveil key functions that are affecting the innovation process (Bergek et al. 2008:408). The key functions are part of the use, diffuse or development of a new technology (Bergek et al. 2008:408).The scheme of analysis and the seven functions will be explained in the following sections.

2.2 Analytical framework

As mentioned above, the innovation and diffusion process is both a collective and an individual act. The determinants of the process are found within firms, but they are also found outside firms. Firms are embedded in innovation systems that aid, constrain and guide the individual actors within them. The process where a technology is diffused in society may be studied using the concept of a technological innovation system, which is a technology-specific innovation system (Jacobsson and Bergek 2004:817). It is said the approach is especially attractive when the focus of analysis is associated technological systems, due to the technology-specific features of the approach.

2.2.1 Technological innovation system

The systemic interplay between actors and firms under a particular institutional setup constitute what Carlsson and Stankiewicz (1991) refer to as a technological system where networks of agents interact and are involved in the diffusion, generation and utilization of technology (Carlsson and Stankiewicz 1991:94). This definition does not make a clear distinction between new and established technologies (Markard and Truffer 2008:599). I will not look at a new technology but the focus will be on an established technology where the diffusion and utilization of the technology is of concern.

The technological innovation systems (TIS) focus on the use of a particular technology (Bergek et al. 2008:408). In my case I will focus on wind power and all its components that influence the innovation process of that technology. The diffusion and innovation process can be both a collective and an individual operation. A firm is a part of a system and the system both constraints and helps the firm's actions. TISs are often international, but may have a geographical dimension. It is a dynamic system and the different components or number of actors can vary over time (Carlsson et al. 2002:236) The TIS can have geographical boundaries but can transcend borders. In this thesis the technological system will be delineated to national borders where the case of analysis is comparative between Norway and Sweden. National boarders stay important when a new technology is to be implemented in a country. National policies and knowledge exchange are important to develop a technology

along with relevant actors within the same country that are a necessity to facilitate the innovation and bring costs down (Vasseur et al 2013:202).

2.2.2 TIS structure

A scheme of analysis that is presented by Bergek et al. (2008) suggests that after an identification of the technological innovation, in my case wind power, one should go on identifying the structural components which are the actors, networks and institutions.

Actors

Actors are the ones that are essential for the development of the technology. These involve organizations, adopters, financers that are directly or indirectly involved in the development of wind power.

Networks

The networks can both be formal or informal where the formal are often more recognizable whereas the informal networks can demand a larger effort to detect (Bergek et al. 2008:413). Networks can be political and are contributing to future expectations, linking the different actors that influence the political agenda (Vasseur 2013:203).

Institutions

Institutions can be identified as norms, laws, culture and regulations. This is an important part to where the technology succeeds or fails to progress and diffuse. RES-E directive (EC/2001/77) in this case is a regulation that influences the TIS. These institutions need to be in alignment with the new technology. The process of alignment is not straightforward (Bergek et al. 2008:414). Firms compete not only in the market but also in a political institutional context (Vasseur et al. 2013:203). The institutions can come in the form of normative and cognitive aspect and as regulations. The divide between normative and cognitive rules is not always clear. Actors are guided to do what they believe is the right thing to do and what they want to do. They are also guided by what they know and are able to do. A way to understand the actors' way of acting is closely linked to the concept of path

dependency (Bergek 2008:4). Normative and cognitive institutions influence the actions and decisions in the context of a technological paradigm[4].

How well a technological system functions, depends on the way in which different institutions, stakeholder, NGOs, businesses and other important entities, act and interact with one another. These interactions or processes are relevant to map whether or not they contribute to the overall goal, both in a positive and a negative way, specifically the implementation and diffusion of technology, in the TIS. To focus on how a number of functions are served in the system Jacobsson and Bergek (2004) explain is a useful way to analyze the workings of a technological system (Jacobsson and Bergek 2004:818).

2.2.3 The seven functions of TIS

The functions approach was first introduced by Jacobsson and Johnson (2000). After that the functions approach has gained prominence by innovation scholars, especially those interested in sustainability (Bergek 2012). The approach have been to some extent been modified by its users the modified approach used in this thesis will be explained in the next section. First a short introduction of the seven functions is made.

As a starting point I will use the seven functions published by Bergek et al. (2008). These functions have shown to be critical in a process of technological diffusion. The functions are as follows:

1) Knowledge development and diffusion 2) Influence on the direction of search 3) entrepreneurial experimentation 4) market formation 5) legitimation 6) resource mobilization 7) development of positive externalities.

The key processes intend to give the researcher a guide to analytically capture the activities and processes at hand, allowing for overlaps between the key processes. The process of technological variety creation by means of experimenting with and producing new technology is referred to as *entrepreneurial experimentation*. To bolster entrepreneurial experimentation and to understand how technological alternatives can be developed for optimal success in the

[4] Dosi (1982) defines the term as "a technological paradigm as "model" and a "pattern" of solution of selected technological problems, based on selected principles derived from natural sciences and on selected material technologies" (Dosi, 1982: 152).

market there is a necessity for *knowledge development and diffusion.* Social structures and personal values are strongly influenced by a society's physical infrastructure, institutions, and the technologies embodied within them. In the process of learning several actors are involved and this leads us to the third key function that is *influence on the direction of search.* There are different actors in the innovation system and the third factor is also pointing to expectations and goals that are important to align the desired future visions of the actors. In addition, mechanisms that are inducing and/or pressuring organizations or firms to enter a TIS is covered in the third function. The disadvantages a new technology has, usually high costs and problem with competing with existing technologies, makes *market formation,* the fourth key function. Market formation usually goes through three phases; nursing, bridging, mature phase. Each phase has very distinct features. The early phase, the nursing market, the size of the market is usually very limited. The nursing markets need to evolve so a timeframe for learning is opened up. The nursing market gives a platform for the possibility of a bridging market. The bridging market allows for an increase of actors in the TIS. The bridging market creates a passage to the mass market. Financial capital and human capital resources are critical for the innovation process therefore is *resource mobilization* the fifth key function. *Legitimation* is the sixth function and refers to increasing the legitimacy of the new technological path in order to overcome obstacles such as resistance by actors that benefit from the existing technologies or overcome inertia in institutional structures. The seventh and final function is *development of positive externalities.* This function is especially important in the process of formation and growth of a TIS. New entries of firms helps strengthening the functions '*market formation'* and '*influence of search'* bringing in '*legitimation'* by strengthening political powers. An improved legitimacy may affect changes in the other functions. The new entrants may contribute to the overall process, benefiting other members of the TIS through the *development of positive externalities* (Bergek et al. 2008: 414-417, van Alphen 2008: 166).

2.2.4 Technological Adaptation System

Earlier literature has focused on a context of development of new technologies. However wind power is neither a new technology per se nor built up as a local industry in either

Norway or Sweden, therefore will the Technological Innovation System be modified for this analysis. Wind power deployment is in a context of a technology implementation and adaptation rather than innovation, in the strict sense this implies that some of the functions have to be modified. It has been argued it can be useful to apply the framework in a different context (Bergek, 2012).

The following factors will be analyzed:

1) Creating adaptive capacity which refers to the enforcing work to strengthening organizational, human and organizational capacity. To continuously adapt to new circumstances capacity building activities, for example national policies for renewable technology, business planning and educational material, are required (van Alphen 2008:166).

2) Demand articulation by users and suppliers. This function includes the guidance with respect to matching the demand in the hosting country. This articulation process must be host driven to be able to make sure that it is addressing, in the case of renewable energy, the mitigation of greenhouse gases. This acts upon the creation of legitimacy (van Alphen 2008:166).

3) Legitimation is a matter of social acceptance or put in other terms, counteracting resistance to change. The renewable energy technology (RET) needs to be in compliance with relevant institutions. In order for resources to mobilize or for the RET to acquire political strength, legitimacy needs to be in place (Bergek et al. 2008:417).

4) Market formation usually needs to be stimulated since there rarely are ready-made markets. For private sector participation there is a necessity for competitive and open markets for RETs. The process of market formation may be affected by governmental regulations, taxes and other similar actions (van Alphen 2008:167).

5) Resource mobilization refers to human and financial capital and is essential for implementing a RET. RETs are often characterized with relatively high costs and political and market uncertainty are perceived risks (van Alphen 2008:167).

The realization of a renewable energy technology (RET) does not rely on techno-economic potential. Many non-technical barriers e.g. insufficient capabilities, political and institutional limitations, hinder the diffusion and implementation of the technology (van Alphen 2008:164). Wind power is a technology that is implemented within an existing energy system. It is not a matter of simply implementing a technology across boarder but the process of adapting a technology to meet local conditions. The factors are modified to be suitable for the situation in which the technology implementation occurs. In the list of functions the creation of new knowledge by R&D is emphasized as a key function (Bergek et al. 2008:414). In the modified list of van Alphen (2008) *creating adaptive capacity* is thought of as a key function (van Alphen 2008:166).

Many actors' behavior and strategies are rarely controlled by any specific actor (Hillman et al. 2011:403). However if the system functions are not fulfilled the performance of the TIS will be hampered. By identifying the malfunctioning system functions guidelines can be identified in order to develop policy instruments that accelerate the diffusion and implementation of RETs (Bergek et al., 2008b; Hekkert et al., 2007). The list of key process is not by any means complete and many scholars have synthesized different lists. The list synthesized by K van Alphen et al. (2008) has shown to be relevant for this thesis.

A TIS is suitable for the analysis of an emerging technological field but this does not apply to this thesis. The TAS is useful in the context for analyzing how to appropriate an existing technology. The focus shifts from understanding how the new technology is used, diffused and developed to how the already used, partly developed and diffused technology can get a stronger encompass to that explicit context which is how it is *creating adaptive capacity*. I understand this function as being a function that covers both knowledge and knowledge diffusion and in that sense strengthening institutional, organizational and human capacity. The function *entrepreneurial experimentation* focuses on the specifics of the technology and its development which is of no interest in this thesis. The functions that are chosen where found to be the most prominent to analyze the empirical data. The functions are entangled and hard to separate from each other but the functions have a strong focus of the

market. Wind power already exists in the Norwegian-Swedish market. The market has already been established thus the focus on *market formation, resource mobilization* and *legitimation* are all functions that have affected the *demand articulation*. All functions are coupled and linked to each other and all functions are recognized but will this thesis will only focus on the five mentioned above.

In order to determine how local conditions promote or hamper wind power investments the innovation system framework is useful, as it discerns all the important political, organizational, social and economic factors that influences the development, use and diffusion of technology (Alphen et al. 2008:164). There are many reasons to believe the environment is biased in favor of the established TAS. One of my research questions is focusing to identify inducement and blocking mechanisms in the Norwegian and Swedish energy systems. The following section discusses the way to identify these mechanisms.

2.2.5 Identifying inducement or blocking mechanisms

The functions presented above are decisive in the process of technology diffusion. The functions may be strong or weak for several reasons. Inducement mechanisms are contributing to strengthening the key processes. One example of an inducement mechanism can be government policy. At the same time government policy can operate as a blocking mechanism affecting many functions. A government policy can for example block the incentive for new firms to enter a new industry thus hampering the influence the directions of search, which affect that the technology never develops a market, making it hard to mobilize resources. If the new technology has no legitimacy within the TIS, it will affect the overall perception of what is desired in the technological systsem (Bergek et al. 2008:422). This also applies to a technology already developed that tries to adapt to an existing electricity system. Blocking mechanisms are on the other hand hindering the development of the functions and one example of a blocking mechanism can be poor articulation of demand. The functions are thought of as processes and are not independent thus some mechanisms block or induce several functions. Inducement or blocking mechanisms are not only found within the TIS but also externally in its surroundings. Bergek et al. (2008) explain that it is useful to map the

relations between functional patterns and inducement and blocking mechanisms in order to understand the dynamics in the TIS, or in this case the TAS (Bergek et al. 2008:421).

While there been many studies on wind power in the Nordic countries (e.g. Pettersson, M et al. 2010) few have analyzed wind power as a technological adaptation system in a comparative analysis in the bilateral green certificate market system between Norway and Sweden. The TIS is useful when analyzing if there are any existing weaknesses in the system structure (Bergek et al 2008:409). These weaknesses or "system failures" as Bergek et al. (2008) refer to; can give pointers to policy makers on where to make changes.

3 Methodology

3.1 Qualitative approach

Qualitative research methods are diverse and it is important to recognize that social research is a human construction reflecting the context within it is conducted. Social science research can be thought of as a political process where the research is used to describe the social world for a particular purpose (Punch 2005:135). Qualitative researchers are concerned with either individual experiences or with social structure. These two fundamental questions can be entangled and hard to separate (Hay 2010:5). Structures constrain or facilitate an individual's behavior but under some circumstances individuals have the capacity to break out rather than to reproduce certain behavior (Hay 2010:6). On the other hand, individuals do not always have the ability or power to overcome the structures in the society. The researcher's job here is to balance between the individuals' experiences and the examination of processes and structures. The research questions function as a lens for the study. Through the methodological approach of functions and interviews the research questions will be analyzed qualitative to give a deeper insight around the concerning field and structures.

3.2 Research design

The interest to investigate how framework conditions, policies and market-forming instruments effect the wind power diffusion in Sweden and Norway has identified the case of research. The research question gives a basis for how a researcher is going to investigate the case defined but one should be aware of that insights the researcher gets along the process can contribute to change the direction of the research question (Thagaard 2009:47). In my case the research question was defined at a later stage in the process. I knew from the start I had an interest of finding out and unveil different factors that affect wind power investments.

A researcher's work on the field is usually designated to a collection of data. The impression one can have is that the "data" just exist for one to collect but when it comes to qualitative method it is important to emphasize that the researcher creates the data in light of the perception one has of the society (Thagaard 2009:47).

After the research question was taking form I designed a plan for how the research process was to be conducted. The decision to interview energy companies came to be most relevant because I searched for closer insight to the wind power industry. One important aspect for the qualitative research is that the research design needs to be flexible and be able to change course in line with the evaluation of the data. The data needs to be pertinent in relation to whether they can bring interesting results (Thagaard 2009:49).

3.3 Presentation of the case

In this thesis a case study has been done. The research design contributes to characterize a case study where profound information is studied about few entities or a case (Thagaard 2009:49). The general idea is that one or more cases are studied in dept, and in its natural setting, recognizing its context and complexity (Punch 2005:144). Yin argues that it can be useful to classify your research question among various types of research methods. My first research question is posed with a *how* which Yin argues is likely to favor the use of case study (Yin 2011:10).

In 2012, a common electricity certificate market, established between Norway and Sweden, came into operation. The goal is to produce more electricity from renewable energy sources with an equal divide between the two countries. The agreement between the two countries is formed in such way that it presents more or less, equal terms for energy companies investing in renewables. I have chosen to focus on wind power technology as the source for generating renewable energy. I delineated the case to only interviewing energy companies that have a natural link to wind power, plans on investing or have invested in wind power. The comparative aspect of the case has been delineated geographical to compare the process of wind power investment in Sweden and Norway. The main interest has been to compare if the context, framework conditions and social perceptions affect the diffusion

process and investments in wind power in spite of a common agreement. As presented in the first chapter (se 1.2) the installed capacity of wind power is considerably smaller in Norway than in Sweden. Hay (2010) claims that a comparative case study is not dependent on the numbers of cases investigated. Instead the researcher has the advantage of using comparative case study in order to understand how the phenomena are manifest in different contexts (Hay 2010:93).

3.4 Collecting data

This thesis will focus on the investment process of wind power and wind power diffusion in Sweden and Norway. Through the enquiry of document analysis in conjunction with interviews in this case study I have gained knowledge concerning wind power. In this way I obtained information from different aspects to *ensure rigour*. To *ensure rigour* Bradshaw and Stratford (2010) explain is about establish trustworthiness of our work (Bradshaw and Stratford 2010:77). I will further explain the different processes of collecting data. The interviews have been the main source for information and the document analysis has been part elucidating the information received.

3.4.1 Documentary data

Documentary data can be a useful source of information where documentary products can be anything from reports, government pronouncements and personal notes to essays (Punch 2005:184). These documents differ in the sense that the information they contain, has been made for a different purpose than the one I have used them for. The advantage with the use of documentary data is that documents are stable and can be reviewed repeatedly (Yin 2009:102). In addition, documents contain exact references, names or details of an event. I have for example used reports earlier made on tradable green certificates, reports on wind power and governmental documents like white papers to get background information. Web

pages belonging to trade organizations (for energy companies investing in wind power) in Sweden and Norway have been a useful source of information on specifics of the wind power industry in both countries.

One disadvantage with documentary data is that it can be colored of reporting bias (Yin 2009:105). Most documents are written for a specific purpose and a specific audience and it is important for the researcher to bear this in mind when reviewing them. An investigator must be precautious to verify the conditions under which the documents have been produced and its accuracy (Yin 2009:106). I reflected upon the contents of documents to put this information up against the information received from the interviews, but I did not come across any specific contradictory information.

3.4.2 The interview

The interview can be described as a face-to-face communication used to investigate diversity of meaning. It is used to fill a gap of knowledge and investigate complex behavior (Dunn 2010:102). Interviews are essential sources of case study information. In addition, the interview is a way to collect different opinions concerning the debate around wind power installment. At the same time, these different opinions can bring some consensus to the debate. It is important to recognize that the interview has a purpose and is not a talk between equal parts. This is due to the researcher's power of interpret and define what is said in the interview (Kvale 1999:19).

The decision to start up and manage a wind power plant is not something you can find out just by reading about energy companies. The only way to find out how energy companies elaborate on taking investment decision on wind power is to go out and talk directly to them. The methodological strength with the use of interviews is the room it opens up for the informant to bring up information they find relevant. The interview is a method with great flexibility where the research question and the questions one wish to get answered are shaping the structure of the interview.

Asking questions

There are different ways to structure your interview guide. I made a semi-structured interview guide that I used through all my interviews (se appendix - 2). This was important to me so I could have an overview over all themes I wanted to cover.

One of the benefits of using a semi-structured interview guide is the flexibility. How each interview is handled will depend on respondent and situation (Dunn 2010:102). Each interviewee is an individual and therefore each interview will be different in some sense. The semi-structured interview is understood as an interview where the questions asked are content-focused and the interviewer is being part of guiding the respondent and redirecting the conversation if it has moved too far from the research topic (Dunn 2010:110). The questions were posed open so it allowed the respondents to talk freely. One of the advantages with the interview in that case, is that it helps me find out what my respondents wish to tell me and they can formulate their own answers. The interview is not only about asking questions, but also about listening (Valentine 2005:122). I thought of making pauses consciously so that the interviewee could bring up themes that I had not anticipated.

Choice of respondents

I had a general idea of wanting to interview energy companies in Sweden and Norway that invest in wind power or are connected to the wind power industry in some way. In qualitative studies that deal with personal or intimate topics can bring challenges to the researcher to find respondents thus one can do participant selections in different ways.

Patton (2002) refers to different employed strategies where snowball (or chain) sampling is one of them. The people involved in the case you research identifies other people involved in related cases for you to contact (Bradshaw and Stratford 2010:75).

The process of finding informants was a little bit tricky and brought some challenges. In Norway the energy companies investing in wind power are registered at NVE. This gave me and overview of companies that could be potential respondents. In Sweden this type of overview of energy companies investing in wind power does not exist to my knowledge. In both Norway and Sweden, I contacted one energy company and used snowball sampling to get into contact with additional respondents. A weakness of this type of participant selection

is the potential for ending up interviewing people linked to the same network (Thagaard 2009:56). However, in qualitative research the sample is intended to give an analysis of meanings in a specific context.

As soon as my first potential interviewee was picked out I sent out a letter that gave a brief outline about my project, what my purpose was and what my thesis wanted to investigate (Yin 2009:83). The response to this letter was often ignored until I decided to contact them by telephone. All of my respondents were positive and wanted to participate after the telephone call. I ended up with six respondents where three are situated in Norway and three are situated in Sweden. One respondent wished for anonymity which made me decide to anonymise all interviewees. In my case the interviewees' names have been irrelevant since they are representing an energy company that invests in wind power. I still have made a brief presentation of my respondents to help the reader get an idea of what types of companies have been interviewed.

The six interviewees

The six interviewees have been found through the snowballing method. Owner structure and how much wind power they have installed differ to some extent. Each company is presented with a small outline of some characteristics. I chose to submit my research project to the Norwegian Social Science Data Services and their main objective is to improve working conditions for empirical research (nsd.uib.no). In the process of collecting my respondents I ensured them their anonymity. Each company will be described with overall characteristics and specific traits are left out to keep them unidentified.

Respondent 1: Medium Norwegian Company (MNC)

This Norwegian company is a wind power division owned by a bigger corporation. The bigger corporation has activities in other areas. They develop projects in the energy sector. They cooperate with other firms that are participating in the energy sector and they also do trading on the energy market. This company's primary focus is on renewable energy sources where wind power is one of the resources. Today they operate a modest numbers of wind

turbines domestically. Internationally they operate more wind power plants and are active on the search to build up more wind power in Norway.

Respondent 2: Large Norwegian Company (LNC)

The LNC is a division of a larger corporation. The larger corporation is an energy producing company. This division works with developing, planning and operating wind power plants. The company is trading on the energy market and has additional activities that are concerning wind power. Their activity is limited to onshore wind power. Today they are working with wind power projects domestically that they are planning to build up in the near future.

Respondent 3: Different Norwegian Company (DNC)

The company can be described as a company focusing on research, information and knowledge connected to wind power and is an actor in the Norwegian wind power. They work actively to maintain a long-term wind power market.

Respondent 4: Medium Swedish Company (MSC)

The company is a co-operative and is publically owned by a region and their core business is energy production and energy distribution. They also do consultant led activities relating the energy sector. Today they operate a smaller amount of wind power plants and have further two additional projects that are ready to implement. They will not build up or invest in any more projects in the near future because of a lacking will internally in the company.

Respondent 5: Large Swedish Company (LSC)

LSC is a subsidiary of a larger corporate. Their core activities are all activities concerning wind power deployment. They manage the whole process from the start phase to operation and maintenance of wind power plant. Today they operate a larger amount of turbines all over Sweden and have many more projects in their portfolio.

Respondent 6: Different Swedish Company (DSC)

The company is a subsidiary of a larger company. The core business of the company is to manage, develop, construct and operate wind farms in the Scandinavian market. With the help of from the parent company they deliver efficient turnkey wind farms. The company also conducts research on wind power industry in Sweden. Today they operate a couple of wind power plants in different parts of Sweden.

Ethical concerns

Every respondent I contacted were presented with an outline of the research project and research questions. It was communicated that this thesis was applied at the Norwegian Social Sciences data services and that I assured them their anonymity as respondents. Attached to e-mail correspondence, I sent out the sheet for informed consent (se appendix -1).In the informed consent it states that they at all time can withdraw from the project.

Recording

Note-taking and audio recording both has their advantages and disadvantages. To use a tape recorder has its advantages in that way that I as a researcher can concentrate on what the informants are saying instead of struggling with getting the interviewees words down on a paper (Valentine 2005:123). A tape recorder also produces a more detailed and accurate conversation than notes. I used a tape recorder for all my interviews and made sure that I had consent before I taped any of my interviewees. As recommended by Hay (2010) I also combined the recording with note-taking during the interviews. Audio recording can also miss important movements and gestures of the informant and miss out on the gist of what was said. During the interview I made small marks and wrote down different points to help me remember connotations, if something was said in an ironic sense and other specifics that can be hard to perceive from listening on a recorder at a later stage.

3.5 Analyzing qualitative data

I have used the analytic approach by Miles and Huberman, where they use sets of six tactics, to analyze the qualitative data (Punch 2005:286). While doing the interview I have used a recorder and that has given me the freedom to take smaller notes of reflections in the margins of the interview guide. Then I sorted out phrases and sentences that have been similar or have differed, amongst my interviewees. Gradually I have elaborated around their comments and made some generalizations. Following step has been to confront these generalizations with the functions of the TAS approach. Each function in has worked as the guidelines for analyzing data. Themes or topics where put together. To connect with any of the functions,

they were collected and put together. Punch (2005) mentions that there are no such things as the right approach to analyze data.

3.6 Validity and reliability

Validity revolves around whether the data has been properly collected and interpreted thus the findings and conclusions reflect and represent the real world that was studied (Yin 2011:78). The means of discussing and describing the approach taken in analyzing and collecting qualitative data is to give the reader an overview of the process to demonstrate the reliability and validity. One should note that the validity is not limited to ones findings. The issue even remains to the simple description of a participant's views. You may think in terms of whether another researcher, given the same orientation, would have gathered the same information and evidence and draw the same conclusion as those in your study (Yin 2011:79).

3.6.1 Reliability

Reliability concerns the "openness of the process" which is thought of as an enquiry where another researcher following the same steps as you have taken, will find similar results. However, in qualitative studies it is rather difficult to achieve absolutely reliability and the focus is bigger on minimizing mistakes and biases in you study (Yin 2009:45). To achieve higher reliability the research process and the method is presented.

3.7 Triangulation

Triangulation is assessed to strengthen the validity of a study. The goal of triangulation is to seek at least three ways of verifying a description or an event. The ideal triangulation can be depicted as followed; the researcher observes an event, then finds an informant who attended

the event and narrates about it, to then find a report written by a third part, who depict the event I this case the triangulation was made through asking different types of energy companies connected to wind power. The empirical data was corroborated with the help of existing literature on the field.

4 Context

As mentioned in the introduction this thesis seeks to analyze how framework conditions affect wind power diffusion. Sweden and Norway are analyzed comparatively because of their establishment of the bilateral green certificate market which makes the two countries cooperate in generating electricity from renewable energy sources. This chapter presents the energy systems, electricity system, the bilateral green certificate system and the other important entities to give the reader the essential background information before approaching the analysis.

4.1 The energy sector

To understand the larger context in which wind power is used and diffused the energy sector is presented to give the reader the wider picture. The energy sector is large and complex and this outline below is just a short introduction to give the reader an overview of where wind power takes part in the system. Generation of electricity from renewable energy sources is a relatively smaller division in the electricity system, within the energy sector. First a short outline is given on the Norwegian energy sector followed by an outline of the Swedish energy sector.

4.1.1 Norway

Energy system

Norway is the third largest exporter of oil and gas in the world after Saudi Arabia and Russia (IEA 2011). In 2009, the oil and gas sector represented 93 percent of total energy production in Norway (oil accounted for 52% and natural gas for 41%). The government's main objective for the petroleum sector is to assure value creation and long-term management on

the Norwegian continental shelf. The petroleum activity is important for creating wealth in Norway and constitutes close to 50 percent of total export from Norway. It is therefore a key sector for the Norwegian economy and has contributed to the Norwegian welfare (IEA 2011).

Other source for energy production is mainly hydropower (7% of total energy production) while biomass and wind power only contributed marginally (IEA 2011).

Electricity system

Demand can be divided into two main categories; electricity from hydropower and oil used mainly by transport sector. Since 1987, electricity is the main energy carrier used, and the consumption per capita is among the highest in Europe (Lafferty and Ruud 2008:250). In 2008 the average use was more than 23 MWh per capita while in Europe the average is estimated to 9 MWh per capita (IEA 2011).

Norway forms a part of the regional Nordic wholesale market Nord Pool (se 4.3. for a more thorough presentation). Efficient use of electricity resources requires a well-functioning electricity grid and the government emphasizes the upgrading of existing connections and the building of new ones, domestically and across borders. Electricity accounts for half of final energy consumption in Norway. A central element to the government's policy is efficiency of the use of electricity.

Norway is connected with the Nordic electricity market and transmissions cables are essential to adapt to electricity security (MoPE 2003-2004). Larger hydropower installations are no longer politically viable and the overall electricity consumption in Norway is increasing (Lafferty and Ruud 2008:250). The slow growth in electricity production in comparison to the increase in electricity consumption can be dealt with by phasing in new renewable energy sources for electricity.

Under the Kyoto protocol Norway has agreed on a 30% reduction of greenhouse emissions in 2020 compared to 1990 (MCE[5]). In addition, Norway has pledged to achieve carbon neutrality latest by the year of 2050.

[5] Ministry of Climate and Environment, White paper 34 (2006-2007). [http://www.regjeringen.no/nb/dep/kld/dok/regpubl/stmeld/2006-2007/Stmeld-nr-34-2006-2007-/4.html?id=473434] [Retrieved 12.02.2014].

4.1.2 Sweden

Energy system

Sweden's total primary energy supply (TPES) has the lowest share of fossil fuels (35% in 2006) of International Energy Agency[6] member countries. Energy supply is the delivery of fuels to point of consumption including generation, transmission, extraction and distribution and storage of fuels. Renewable energy sources have provided around 28% of TPES (IEA 2008). Sweden has abundant renewable energy sources and a strong nuclear energy programme as a result of the government's effort to reduce dependence of oil.

Energy intensity is one of the highest in the IEA. This is explained by the industries heavy energy usage, most in iron, steel and pulp and paper. Industry is the largest user of energy that accounted for 42% (IEA 2008). The transport sector accounted for 24% and other sectors accounted for the rest. Since the 1970 the total final consumption of energy (TFC) in Sweden has been stable whereas the TPES has grown by a third (IEA 2008). The energy efficiency and slow economic growth have been factors that have contributed to the steady consumption.

The government expects the total final consumption of energy to increase by 18% by 2020. Energy use is expected to increase in the industry whereas consumption in households, services and transports is projected to remain steady (IEA 2008).

Electricity system

Sweden's electricity supply is dominated by nuclear and hydropower accounting for 90-92% of the country's annual electricity generation (SAE 2013). The rest is generated from natural gas, coal, oil, wind power and biomass. For power systems dominated by hydropower, precipitation levels are a key determinant of production levels and of the production mix in Sweden and the Nordic market. Sweden is a net exporter during wet years, reflecting the relatively low marginal cost of hydro generation (IEA 2008). During dry years Sweden is a

[6] The IEA is an autonomous organisation which works to ensure reliable, affordable and clean energy for its 28 member countries and beyond [http://www.iea.org/aboutus/][Retrieved 10.01.2014].

net importer, mostly from Finland and Denmark. Sweden is part of the Nordic electricity market, Nord Pool.

Changes in the structure of electricity supply reflect the increase in TPES. Electricity use has increased due to use of electricity heating, district heating and heat pumps. Combined heat and power generation (CPH) is also extensively used. Today electricity generation is almost CO_2 – free: depending on hydrological conditions, nuclear and hydro account for some 90%-92% of total energy production (IEA 2008). The rest is biomass. Sweden therefore emits little CO_2 per capita as a result of the structure of its TPES.

Electricity cannot be stored and needs to be balanced between supply and demand. The energy balance has been relatively stable over the years (SAE 2013). Sweden has a high dependence on electricity, both in the industries and housing and service sector. A debate that has been going on in Sweden is the issue about phase out nuclear power. If this would be the case, there is a necessity to produce more electricity from renewable energy sources.

Climate strategy

One of the key objectives of Sweden's energy policy is environmental protection. Climate change is the biggest challenge and the government's energy policy targets by 2020 are to reduce greenhouse gas emissions by 40%. Additional target are to get a 20% more efficient energy use, and at least 50 % renewable energy in the energy sector. The government also aims at a minimum 10% renewable energy in the transport sector (MTE)

There are different incentives to produce electricity from renewables in both Norway and Sweden. What type of RES-E energy companies decides to invest in depends on different institutional frameworks. Further is a presentation of how the energy production divided by energy source looks like in each country.

4.2 The electricity production

The physical structures of the Norwegian and Swedish energy sectors differ. In 2012 the total of electricity produced was estimated to 147,8 TWh. 142 TWh of the production of electricity was produced from hydropower which comprise the main source. 3,3 TWh comes from thermal power production and 1,5 TWh from wind power. Depicted in figure 2 is the electricity system in Norway.

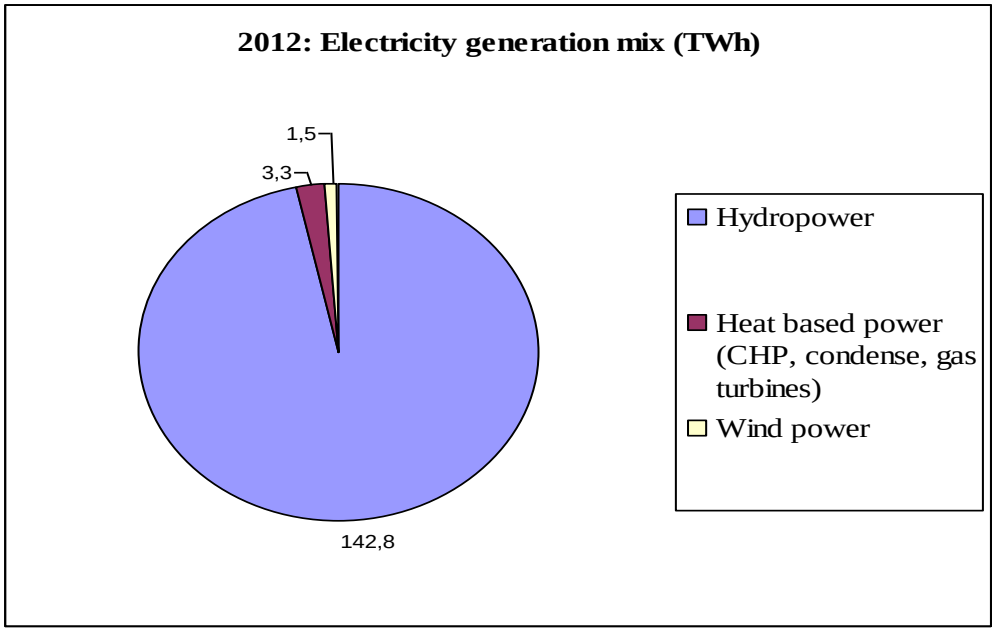

Figure 2 Electricity generation mix in Norway (Source: NVE 2012).

The Swedish energy system consists of both non-renewable and renewable energy resources where the divide from different energy resources looks a bit different from the Norwegian energy system. The total energy supply in Sweden in 2012 summed up to162,4 TWh. Depicted in figure 3.

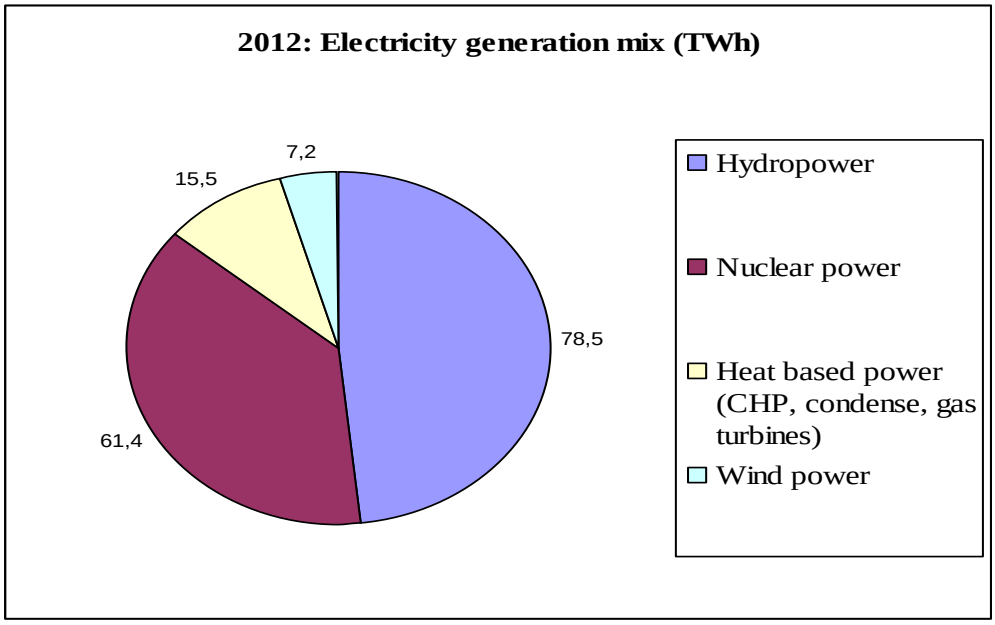

Figure 3 Electricity generation mix in Sweden (Source: SAE 2012).

The Swedish energy system is a heterogeneous system with a large energy mix. Hydropower was estimated to 78,5 TWh, nuclear power to 61,4 TWh, conventional thermal power to 15,5 TWh and wind power to 7,2 TWh. These figures show that Sweden has an energy system where around 60% of the electricity generation comes from renewable energy sources (SAE 2013). Sweden needs to take measures to reduce its dependence on fossil fuels. To deploy in renewable energy sources Sweden will be able to transform its energy system

The physical structures of the energy systems show that Norway is challenged in a different way than Sweden in deploying in new renewable resources. Norway is not in a critical need to transform their energy system while it consists of 96,7 % of hydropower that provides the domestic demand of electricity (Hanson et al. 2011:11). The historical development in Norway has made hydropower a dominant energy system (DES). The first hydropower plant producing electricity for households was constructed in 1885 (Lafferty and Ruud 2008:253). Between 1905 and 1920, the industrialization of Norway was characterized by hydro-based electricity. Traditionally the Norwegian government subsidized the energy-intensive industries with low-cost supply of electricity. The most intensive period where hydropower was constructed was between 1970 and 1985 but started already in the early 1960s. Today hydropower is still crucial for the country's industries, and the relatively low

costs are regarded as influential for the future industry. Amongst OECD countries Norway is the third largest with hydro-based electricity producer (Lafferty and Ruud 2008:253).

The history of Sweden's energy system is partly different from Norway's. Already in 1880 Sweden started exploit hydropower for local small-scale use. In early 1900s large-scale hydropower appeared alongside transmission lines that the Swedish Government invested in. The expansion of the industry created the desire for cheap electricity and rapid exploitation of hydropower resources occurred. Hydropower expansion decreased around 1950s and by 1980 it all came to stop, much due to public opposition. In the post-war era the availability of cheap fossil fuels enabled the Swedish economy to grow (Lafferty and Ruud 2008:222). The growth of energy imports ended with the oil crises in the 1970s. Nuclear power was developed through the desire to provide cheap electricity and in the 1950s nuclear power had a "clean" image and was considered less controversial than hydropower (Lafferty and Ruud 2008:223). In the 1970s nuclear power colored many debates, both public and political ones (Lafferty and Ruud 2008:223). Nuclear power became the second major component in the electric power sector during the 1970s. The first reactor in Sweden came into operation in 1972. Alongside nuclear power became large-scale hydropower, the second important component in the Swedish energy system.

Power is a vital element that supports our lives at work and home. As transmission capacity and power production has been extended transmission of power between countries has become common. The Nordic energy market has enabled Norway and Sweden to agree on a common certificate market. First Nord Pool is presented followed by a presentation of the bilateral green certificate system and TGC.

4.3 Nord Pool

In the early 1990s the Nordic countries established a common market for electricity distribution. This is organized through Nord Pool, and creates (ideally) an integration of the electricity systems including both physical transmission of power between countries; shared rules and regulations and in principle shared prices. (Nord Pool Spot[7], no date). The Nordic

[7] [http://www.nordpoolspot.com/About-us/History/] [Retrieved 02.02.2014]

countries deregulated their power markets and brought their individual markets together into a common market. The term ‘deregulation’ means that free competition is introduced in the power market and the state is no longer running the market. Deregulation was initiated to create a more efficient market with increased security of supply through the exchange of power between countries (Nord pool spot, no date).

The balance between supply and demand determines the power price (NVE, no date). Factors such as power plants not producing to their full capacity or the weather can impact the ‘transmission capacity’ or how much power can be transported through the grid thus influencing the price of power. There is a general agreement among politicians and other stakeholders in the Nordic power markets that this power model serves society well (Nord pool spot, no date).

For this thesis the main point is that Norwegian and Swedish agents in the electricity market operate within a common market and with shared power prices. Different electricity prices should therefore not influence decisions on investments in RETs in the two countries.

4.4 The agreement

The agreement of establishing a bilateral green certificate system is essential for this thesis. The starting point for a joint electricity market to be working optimal is that the framework conditions are as similar as possible (MoPE/ MEEC, 2012). To find out if the framework conditions are similar and if the potential differences have an effect on what renewable energy resource investors choose is of interest in this thesis.

The basic principle should be to promote investments in power plants producing electricity from renewable energy sources by providing sufficient financial support. The power plants should not receive additional financial support besides the TGCs. The Swedish Ministry of Foreign Affairs published the agreement between Norway and Sweden in a common bilateral market for green certificates where the different ground rules are established (Sweden’s international agreement 2012:3). Both parties have signed the agreement where:

- They have the perception of the common certificate market to have a positive effect on the work to promote electricity production from renewable sources.
- Both parties have acknowledged the framework conditions for the system and will contribute to create long-term solutions and believe in the system.
- The two countries will seek for in the period from January 1st 2012 to December 31st 2035 to annul electricity certificates corresponding to 198 TWh in each country.

The different renewable energy sources included in the TGC scheme are:

a) Hydro Power	b) Wind Power	c) Solar Power
d) Wave Power	e) Geothermal Power	f) Biogas (in Sweden it also includes peat in CHP[8]).

Figure 4 The different renewable energy sources included in the TGC scheme. (Source: Lovdata).

Even if the fundamental principles are the same, there are some differences in the two countries' legislation. In Sweden, plants that become operational after 2020 can receive electricity certificates whereas in Norway they cannot. In Sweden, peat is a part of the renewable energy sources that is entitled electricity certificates. In Norway the proportion of biofuel in mixed wasted is qualified for electricity certificates (SAE/NVE 2012).

The conditions for both countries are per se equal in that sense that both countries are given the possibilities to establish new power producing plants, with the benefits of receiving concession, when using renewable resources for electricity.

4.4.1 Tradable green certificates

The TGCs are implemented to stimulate investments in production of electricity from renewable energy sources. The authorities offer power producers electricity certificates. The

[8] Combined heat and power [http://en.wikipedia.org/wiki/Cogeneration]

electricity certificates are tradable and provide additional income for producers of electricity certified as renewable. The costs of purchasing certificates are added on the electricity bill which means that the power customers are the once financing the system (NVE). For each MWh of electricity generated the power plant receives one electricity certificate from either NVE in Norway or the Swedish Energy Agency in Sweden (NVE, 2012). The TGCs are technology neutral hence it is up to the investors to decide what type of renewable energy sources to invest in (SAE/NVE 2012). This generates different investments patterns in Norway and Sweden when the power producer can choose to invest in the renewable energy source where the profitability is highest. That is not to say that this always is the case. The price of electricity certificates is determined by supply and demand. Depending on how much electricity is being produced effect the supply. The demand is determined by the set electricity certificate quota for each year and how much power is being used (NVE). The obligatory quota will ensure an annually growing demand for the green certificates in the market. It is expected that this will stimulate investments in new capacity. Below is a figure showing the process:

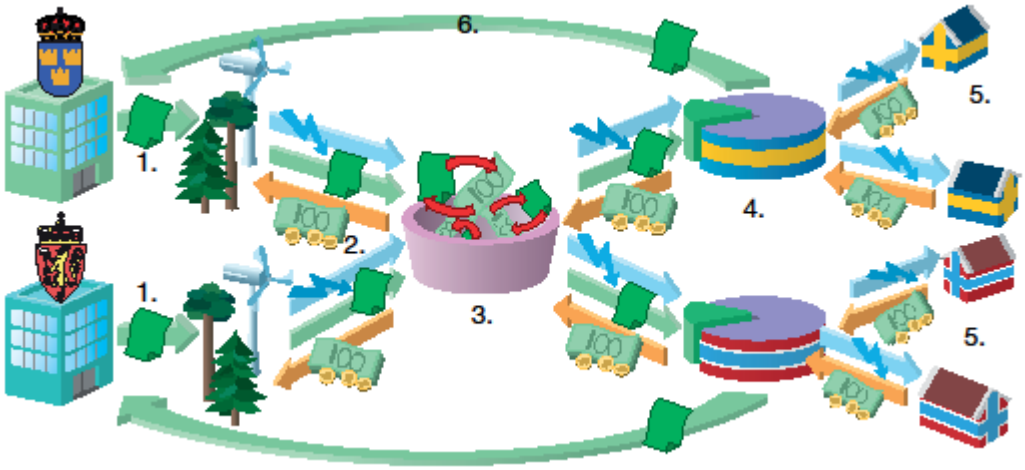

Figure 5 The bilateral green certificate market (Source: SAE 2012).

1. Electricity producers in Norway and Sweden receive one electronic electricity certificate from their government for each MWh they produce from renewable energy sources.

2. The electricity producers can sell their certificates with the possibility to make an extra profit of their electricity production.

3. Norwegian and Swedish certificates are traded on an open market. The price of the certificate is determined by the sellers and buyers.

4. Purchasers are Norwegian or Swedish parties having quota obligations which mean that they are required to purchase certificates corresponding to a quota of their electricity use or sales. The size of the quota obligation is set by the requirements of the concerning legislations, thus creating a demand for certificates.

5. If the purchaser is an electricity supplier, the expenses for the acquired certificates forms part of the price that the supplier charges his customer. In this way contribute the Norwegian and Swedish electricity consumers to the expansion of production facilities for renewable electricity.

6. Each year, on 1st of April, are those having a quota obligation required to hold the necessary numbers of certificates to meet their quota. The registrars will then cancel the right numbers of certificates. Between that date and 1st of April the following year, the parties must purchase new certificates needed in order the meet the next year's quota obligation. The constant demands for certificates are in this way created by the scheme that makes those having a quota obligation to meet their required quota (NVE/ SAE 2012).

Prices of TGC

If you take a quick look at diagram below (presented in figure 9) the prices from 2006 to 2014 shows that the prices have gone up for then to go down again. In January 2006, an electricity certificate cost 177, 90 SEK and rose in 2008 to the double and peaked in August costing 372 SEK. The prices were kept relatively high the following year and slowly decreased in 2010 and 2011. Today the prices are equivalent to the prices in 2006.

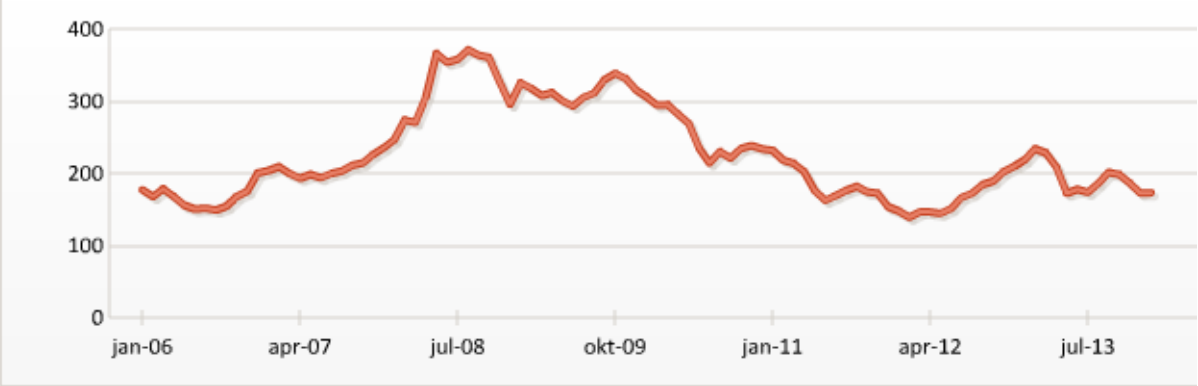

Figure 6 Timeline from 2006-2014. Average prices on electricity certificates SEK. (Source: Ekonomifakta.se)

The expenses for a wind power plant are reasonable higher in wind power compared to hydropower (vindportalen, no date). Wind power investments are characterized with high front up expenditures but relatively low operating costs. Once a power plant is built it can produce electricity at a low price because the wind is for free. Even if the wind is for free, to cover for the high expenses in advance, the electricity needs to be sold at a higher price. This can be achieved with high electricity prices or with an electricity price in combination with a subsidy (vindportalen, no date). It is clear that the energy companies, potentially investing in wind power, are very preoccupied of the prices of the Tradable green certificates.

4.4.2 The role of Tradable green certificate (TGC)

It is expected that the renewable energy resources will meet obstacle when integrated into a liberalized market. Incumbent technologies are often more reasonable in price in comparison to new technologies. In addition, incumbent technologies often attempt to block the diffusion of renewables through the influence of institutional frameworks. The influences on the institutions are kept the same as an advantage for the incumbent technology (Jacobsson and Bergek, 2004:817). The implementation of technology is challenged in several ways but to develop a separate green certificate market is a way to enable the integration of renewables into the liberalized power market. With the help of the TGC system, the renewables can be

economically compensated for the environmental benefits they generate compared to conventional power production (Mohorst 2000:1086).

Why a joint scheme?

The Swedish Ministry of Enterprise, Energy and communications motivated the collaboration by pointing to a better functioning market. The joint scheme will lead to higher liquidity and better price formation. In addition will the bigger market be more attractive for investors. Also the access to a larger production base will help to increase cost-efficiency (MEEC, 2013). There is an important boundary between those innovations that can be made through market activities compared to those that have big limitations for what can be done through market activities. There is a direct link between to what type of innovation that is executed and politics and incentives (Smith 2011:24).

4.5 Differences in spite of similar support system

One factor that is directing what types of renewable sources are invested in is closely linked to the structures of the specific country's energy system. Even if Norway and Sweden have formed a policy that presents equal conditions for both countries it manifests as a discrepancy in different RES-Es.

A report presented by the SAE and NVE in 2012 showed that in the first year of the Swedish-Norwegian electricity certificate market 3,2 TWh of new expected mean annual production became operational. 0,4 TWh was constructed in Norway whereas 2,8 TWh was constructed in Sweden. In Sweden wind power represented 68 % of the new expected mean annual production included in the joint goal. In Norway, new hydro plants was the primarily source that contributed to the increased expected mean annual production in Norway. Wind power was not included in this estimate because the wind power plants that became operational in 2012 decided to retain the investment grant from ENOVA which excludes them from being part of the joint electricity certificate market (SAE/NVE 2012).

As mentioned in the introduction there is a potential to implement more wind power in both the Swedish and Norwegian electricity systems How much wind power and in which country this implementation will take place remains an issue for the future to tell. However, to identify how framework conditions and other mechanisms affect wind power diffusions can be helpful to give pointers to policy makers on where to intervene.

Companies are interested in return of investments (ROI). The TGCs, taxes and other financial differences are part of the calculation of possible ROI for a company, but that is not the only factors influencing a potential investment decision. Other aspects can be enlightened with the help of the TAS functions approach. In the next part the comparative analysis will help to unveil what factors that influence the wind power Technological adaptation systems in Norway and Sweden. The interest lies with the actors' investment decisions thus affecting the diffusion process of wind power in Norway and Sweden.

5 Structure of the TAS

The aim for this thesis is to analyze how framework conditions challenges Norway and Sweden differently when they try to implement wind power in their electricity system. As elaborated in the theoretical chapter, after defining the boundaries of the TAS, one has to identify its structural components. These have been elaborated in the context chapter but will be summarized briefly in the following chapter.

5.1 Norway

Actors

The actors can be thought of as the ones that are technically, financially and politically so powerful that they influence the diffusion process (Jacobsson and Bergek 2004:817). In Norway, the Ministry of Petroleum and Energy (MoPE) has the main responsibility to carry out energy policies. Ministry of Climate and Environment has the mission to pursue an aggressive climate policy and strengthen the climate accord by increasing efforts in new, climate-friendly technology, public transport, and establishing a green tax commission (MCE, 2013)[9].

This thesis focuses on the bilateral green certificate system and all concerned entities that the system is affected by. NVE is the subordinate agency of the MoPE. They have the responsibility for managing the water and energy resources on mainland Norway and are the national regulatory authority for electricity (NVE)[10]. Its tasks are to promote efficient electricity trading and efficient energy use and responsible to manage environmentally sound handling of river systems. They are responsible for handing out concessions in Norway. Energy companies address the NVE for a possible approval for a potential wind power project. In this process other actors are affecting the outcome of the final decision.

[9] Information found at Ministry of Climate and Environment homepage. [http://www.regjeringen.no/en/dep/kld/press-centre/Press-releases/2013/the-ministry-of-the-environment-becomes-.html?id=748447] [Retrieved 19.04.2014]
[10] Information found at NVE's homepage. [http://www.nve.no/no/Om-NVE/] [Retrieved 29.01.2014]

Wind power plants are dependent of a grid connection. Statnett SF is the Norwegian transmission system operator and owner of 87% of the transmission grid. The grid connection has to exist or be built to implement a wind power plant. Statnett is supervised by MoPE and owned by the government.

Concessions are handed out by NVE, in the form of a tradable green certificate, or by Enova. Enova SF is a public enterprise owned by MoPE. Its task is to promote new renewable sources of energy and environmental-friendly use of natural gas.

Private companies and energy companies are the investors in wind power. Statkraft[11] is Europe's largest generator of renewable energy and is wholly owned by the Norwegian state. Wind power is not only owned by large companies but also other private companies. Regions or municipalities have established co-operatives and are also owning and investing in wind power. The purpose of the co-operatives is that the owner of the power plants and the electricity produced is also utilized by the members of the co-operative (Wizelius 2009:42). If you take a quick look at wind power investors in Norway, the owner structure of limited company (AS in Norwegian) which is limiting liabilities of stockholders to the extent of their investment, seems to be the most common one.

Kjeller vindteknikk AS is a company that offers the service of measuring wind and searching for good locations for wind power plants. Other research institutions in Norway are primarily focusing on off-shore wind power technology thus will not be further elaborated in the analysis

There are different actors in Norway working to promote wind power. Organizations are also contributing to legitimize the technology. The Bellona foundation is a non-profit organization that "aims to fight climate challenges through implementing and identifying sustainable environmental solutions" (www.bellona.no, no date). NORWEA[12] is an interest- and trade organization that works actively to promote wind power in Norway. Energi Norge is a non-profit industry organization representing about 270 companies involved in trading, production and distribution of electricity in Norway, to mention some. The mentioned actors are all influencing the diffusion of wind power in some ways.

Networks

[11] [http://www.statkraft.no/om-statkraft/] [Retrieved 29.01.14]
[12] [http://www.norwea.no/om-norwea.aspx] [Retrieved 15.01.2014]

The networks are the channels for the transfer of both explicit and tacit types of knowledge. The focus of the market in this case links both the authorities, energy companies and interest organizations to wind power mentioned above. They all contribute in some way to the perception of what is desirable e.g. shape the actors' vision of the future (Jacobsson and Bergek 2004:818). NORWEA can be understood as a formal network but informal networks may also exist. Bergek et al. (2008) suggest different measure to take in the search for informal networks, like starting a dialogue with industry experts (Bergek et al. 2008:413). NVE and energy companies and interest organizations have different arenas where they meet and exchange information thus can be considered an informal network in the wind power TAS.

Institutions

Institutions such as regulations, norms and culture need to be identified as they are defining the framework conditions for the innovation activities. The roles of the institutions vary; some influence the structure of demand, some affect the incentive structure whereas some influence the connectivity in the system (Jacobsson and Bergek 2004:818).

The common green certificate market has been established in accordance with the RES-E Directive (EC/2001/77). The Norwegian government is part of regulating or providing explicit policies for wind power. They can influence by regulations creating the desire to invest in more wind power in Norway. These explicit policies do not exist in Norway. Tax policies and market regulation are also part of affecting the institutions.

The NVE has the main responsibility to manage the country's water resources and to promote an efficient energy market. They have an important role to regulate the electricity market. They decide what companies receive concession for a buildup of wind power. The process of concession is in many cases influencing the institutions, in such way, if more energy companies receive concessions for wind power plant they send signal to the investors that wind power is desirable. Statnett has the coordination role to make sure that Norway makes use all electricity produced.

The possibility for an increase in investments in RES-Es has been facilitated. Energy companies can receive concessions for investing in RES-Es. Many energy companies in Norway have invested or invest in hydropower in Norway (NVE 2013). This indicates there is

a competition in the market. Firms not only compete on the market but compete to collectively gain influence in over the institutional framework (Jacobsson and Bergek 2004:821). It is stated that the electricity consumption will increase but the production has been relatively stable over time. Interest organizations are important actors to promote the implementation of renewables but there seem to be disagreements of what type of technology that should be. Authorities that grant or facilitate wind power planning are all part of influencing the connectivity in the system.

5.2 Sweden

Actors

In Sweden, Swedish energy policy rests with the central government supported by local authorities and different implementing national governmental authorities. The Ministry of Enterprise, Energy and Communications (MEEC) is the ministry primary in charge of energy policy. The Swedish Environmental Protection Agency has the responsibility for environment policy and environmental scenario forecasts. The National Board of Housing, building and Planning is managing water and land resources and building and housing[13].

The Ministry of the Environment is in charge of environment and climate policy. The Division for Climate leads negotiations regarding EU climate change and Nordic co-operations. The Ministry of Health and Social Affairs is in charge of the Planning and Building Act that governs the control of environmental planning and construction work.

Under the Ministry of Enterprise, Energy and Communication operates the Swedish Energy Agency (SEA). This is the central governmental agency responsible for implementing energy policy. It is the administration of the electricity certificate system and the promotion of wind power development. In addition, the SEA controls the implementation of energy efficiency measures and support, development and demonstration to innovation.

The Swedish National Grid is the transmission system operator and operates the national high-voltage electricity grid. They are also responsible for the security of electricity

[13] http://www.iea.org/textbase/nppdf/free/2013/sweden2013_excerpt.pdf

supply. For all wind power projects, the access to grid is crucial in the implementation of wind power which makes the Swedish National Grid a crucial actor.

The County's Administrative boards (CAB) which embody the national government at the regional level are assigned from the government to formulate regional climate and energy strategies in collaboration with regional actors. The CAB has mandate to hand out concessions for wind power projects in Sweden.

Municipalities have control over the physical planning, in accordance with the Planning and Building Act, and can decide how much and where wind power can be installed (Åstrand and Neij 2006:286). The Tax and Customs Department has the general responsibility for designing taxation instruments, including in the area of energy.

Large actors in wind power in Sweden are energy companies like; Vattenfall, E.ON, Fortum and Statkraft, to mention some (EI 2013:04). Vattenfall is the largest single actor in the power market and is 100% owned by the Swedish government. E.ON is one of the world's largest private energy companies. Fortum is another large energy company that operates on the energy market.

Since the introduction of investment subsidy in 1991, the numbers and types of actors have increased. Cooperative forms of ownership became common and the number of wind energy developers increased (Åstrand and Neij 2006:284).

New types of actors and wind power companies appeared during the 1990s, so called wind energy developers. These companies for example sell services in authorizations, grid connection and financing. Wind energy developers e.g. negotiate with land owners of good wind sites for potential establishment of wind power (Åstrand and Neij 2006:285).

Stakeholder organizations active in the governance of wind power in Sweden include environmental NGOs, like the Swedish Society for Nature Conservations. The Swedish Wind Energy, a trade organization for large wind power providers, is another organization that influences the TAS of wind power in Sweden, to mention some (Svensk Vindenergi, no date)[14].

Networks

[14] [http://www.vindkraftsbranschen.se/en/] [Retrieved 20.03.2014]

There exist both formal and informal networks in the Swedish TAS of wind power "Network for wind power usages" is a formal network that works actively to share knowledge about wind power. There exist different organizations that work actively to promote wind power in Sweden. "Network for wind power usage" ("Nätverket för vindbruk") (nb. own translations) was established in 2008 on behalf of the Swedish government. Their role is to share knowledge and information about wind power and the Swedish Energy Agency is the coordinator for this network (SAE, no date).

NVE and SEA have collaborated on writing reports that treat the common electricity market (se 4.6.1). Energy companies are members of trade organizations that work as an arena for different actors, where they share knowledge and experiences. These workshops and meetings can be considered a more informal type of network.

Institutions

The RES-E Directive (EC/77/2001) is the regulation that has influenced both Norway and Sweden to take the decision of collaborating in a common certificate market. They stipulated the rules that interaction between energy companies in the energy market receives concessions for investing in a renewable energy resource. The institutions like the SEA, County Administrative Boards and the municipalities all are authorities in the concession process that connects them with energy companies. The number of concessions and grants are all part of sending out signals to other energy companies that potentially are thinking of investing in wind power and they all contribute to influence the incentive structure of demand.

Trade organizations and interest organizations are all contributing to influence the normative institution through the influence of what technology is preferred.

To sum up, actors, networks and institutions of the Norwegian TAS and the Swedish TAS of wind power have been presented. The next step in the analysis is to describe the functional patterns to find out to what extent the functions are filled in the TAS. These functions form a level in-between the components of the TAS and its performance (Jacobsson

and Bergek 2004:818). This step has normative no normative features (Bergek et al. 2008:414). It is important to bear in mind that the functions below are not working independently but are understood as processes that affect each other. A change in one function, can lead to change in one or more functions (Jacobsson and Bergek 2004:819). How well each function is assessed will be discussed later in this thesis.

6 Analysis of the functions

To put the TAS into practice I followed three steps. In the first step I have investigated the constellation of actors, networks and institutions of wind power within both countries. In the second step I have focused on the fulfillment of the five functions. The approach is based on a collection of events and to allocate them by indicators to the respective system function. Data is collected from journals, governmental papers, reports, research papers, websites and interviews with energy companies in Norway and Sweden. By presenting the material per function a direct comparison with the Norwegian TAS and Swedish TAS will be possible. In the third step the linkages are drawn between the analysis of the structure in the innovation systems and the functions to reveal inducement and blocking mechanisms. This is followed by a discussion and suggestions for policy makers on where to intervene.

Table of indicators per function:	
Function 1: Creating adaptive capacity	National policy for wind power, capacity of people/org., educational material
Function 2: Demand articulation	Need for implementation
Function 3: Market formation	Phase of market, tax regimes, concession process
Function 4: Resource mobilization	Capital and infrastructure
Function 5: Legitimation	Lobby activities for/against the technology

6.1 Norway

6.1.1 Creating Adaptive Capacity

Creating adaptive capacity is required to develop institutional and organizational capacity and strengthen human capacity. New technological trajectories for an economy imply new social challenges (van Alphen 2008:166). Norway has committed to produce more RES-Es but there is no explicit policy promoting wind power. The regulating body NVE has the mandate to decide how many wind power projects get concessions. Most of the Norwegian wind power companies possess both knowledge and expertise on the field. In addition, there exists external consultancy for other areas when the company is in need for that. There are no signs of lacking local technicians for the operation or maintenance of wind power turbines, but there is a request for more institutional competence around grid access. Educational material is easy accessible in Norway for those who may need it.

National policy for wind power

Late 1990s governmental policy targets were introduced to increase use of RES-E and energy efficiency (Blindheim 2013:337). For the first time, the Norwegian government adopted a long-term scheme in 1999 where 3 TWh onshore wind power target should be reached by 2010. By 2010 the target was not met and only 1 TWh was produced from onshore wind power (Blindheim 2013:337). In 2006 the Norwegian government established a goal to produce 30 TWh per year increased energy supply from renewable energy sources (Regjeringen, 2007). The Norwegian government stated that Norway should facilitate expansion of wind power and in addition provide a more efficient and predictable concession process for wind power developers. More than ten years ago there was suggested a market subsidy with different politicians showing their support to wind power. Increased expansion of wind power is mentioned in the Soria Moria declaration on renewable energy where TGC was central to the climate agreement that was adopted in 2008 (ONR, 2012:16[15]). Unpredictable conditions have hampered the expansion of wind power.

The regulating body in Norway right now is the RES-E Directive (2001/77/EC) that puts pressure on phasing in more renewable energy in the electricity system and the NVE, working under the mandate of MoPE, is the regulation body. NVE presents updated reports on the energy system. Statistical and technical information about electricity production and electricity consumption is collected in monthly, quarterly and yearly reports (e.g. Energistatus

[15]Official Norwegian Report, 2012:16 "Climate agreement" [http://www.regjeringen.no/en/dep/fin/Documents-and-publications/official-norwegian-reports-/2012/nou-2012-16-2/10/3/1.html?id=713589] [Retrieved 21.03.2014].

and Energi i Norge, NVE, 2013). NVE has also information of wind power where of mapped potential sites for wind power plants. In addition to this they present a map of terrain complexity which is an important factor for an investor when considering investments in wind power (NVE, 2013)[16]. It seems the activities at NVE are more about bringing information about wind power rather than promoting for wind power.

The TGC are implemented as a financial incentive to undertake renewable energy technologies but the TGCs are technology neutral. As earlier mentioned (se 4.5), in Norway this has shown to most of the investments in hydropower. The strong tradition of large-scale and low-cost hydropower has dominated the country's power generation sector and role of direct government influence has been less prevalent (Pettersson et al. 2010:3119). To promote a higher degree of investments in wind power there needs to be a stronger direct influence.

Capacity of people and organizations

Norway's resources have been exploited for decades and the link between hydropower generation and the overall consumption of electricity is affecting RES-E in Norway. Historically, decisions related to energy production have been involving hydropower. In 1969 with the discovery of the oil and gas Norway became the world's third largest oil- and gas exporter which had powerful impact on the energy politics (Hanson et al. 2011:11). But petroleum never challenged hydropower as a dominant domestic electricity source (DES) (Lafferty and Ruud 2008:253). In 1982 the Norwegian government prepared for the white paper on RES. One way was through the mapping of wind power potential and cost and benefits calculations (Buen 2006:3891). NVE initiated in 1989 a demonstration programme for wind energy. Through the establishment of 15 grid-connected wind turbines they wanted to gain experience about wind power development and wind industry. The programme did not have any greater impact on the installed capacity or average production capacity in wind industry. However, the lack of funding to initiate development of prototypes hampered the future prospects of developing wind power technologies in Norway. The absence of a domestic wind power industry does not seem to have an effect to wind power investors.

All the Norwegian respondents stated that they all have quite similar approach when they deal with a wind power project. They start by finding a project, then the map the

[16] Information found at NVE webpage. [http://www.nve.no/no/Energi1/Fornybar-energi/Vindkraft/][Retrieved 29.01.2014].

infrastructure and topography, roads, measure winds etc. Then they look up conditions for property; look for possible conflicts the can come across, cultural heritage, scenery and so on. Some companies have all the knowledge they need concerning wind power planning internally and some take use of consultants when they need knowledge they lack internally.

> Our company is a limited company where the owners and stockholders consist of different energy companies. These two companies have great knowledge about wind power. They know how to measure winds, do maintenance of a wind power plant, and they have their own resources. When the company has this access to knowledge we find no need for building up special competencies internally. Whenever we need expertise we go to our shareholder and bring in the knowledge needed (LNC, personal communication 02.12.2013).

It was also stated that the market for wind turbines is large and it is just a matter of finding the ones appropriate for their project, searching for a supplier who offers good prices. In a study made by Thema Consulting group (2012) they concluded there exists few challenges on the supplier side, entrepreneurial activity or consultant activities in wind power (Thema Consulting, 2012).

One respondent pointed to problems with coordinating information between different investors and finding information concerning grid access when several projects need to access the same service transformer[17]

> (…) we received a go from NVE but this was further appealed. There was a plan to start building the wind power plant in 2011 but we entered some problems. Two projects physically bordered each other and they were supposed to be connected in the same transformer. Every concerned company needs to bring detailed information to make the projects feasible. This is a rather complicated task and takes a lot of time and work (MNC, personal communication 09.11.2013).

Thema Consulting group (2012) also found in their work that engineers and technicians for building of transformers in Norway are lacking (Thema Consulting group, 2012). This was also apparent in my interviews where they emphasized complex situation connected to specific knowledge in grid access.

[17] A transformer is a static machine used for transforming power from one circuit to another without changing frequency [http://www.electrical4u.com/electrical-power-transformer-definition-and-types-of-transformer/] [Retrieved 19.04.2014

Educational material

A quick search on the internet shows that almost every energy company in Norway presents information and facts about wind power. Vindportalen is a webpage where collected information of anything from history, actors and networks, to the concession process, and other essential aspects of wind power in Norway are presented. NVE arranges and hold seminars where they present updated information about activities in the bilateral green certificate system and other relevant information concerning wind power (NVE, no date). Trade-organizations and other NGOs, like EnergiNorge and NORWEA, are part of bringing information about wind power in the shape of reports treating different aspects of the wind power industry.

To sum up, there exists a regulation that promotes RES-E investments but these investments are mostly done in hydropower. There are no signs pointing to that there is a lack of manpower in planning, implementing and monitoring wind power projects. Educational material is easily accessible and NVE, NGOs and Vindportalen, to mention some, are contributing with this material. As aforementioned the consumption of electricity is expected to increase in Norway but the production of electricity has remained relatively stable (Lafferty and Ruud 2008:250). With the goal of producing 13,2 TWh from renewables the question remains in what types of renewables are invested in.

6.1.2 Demand articulation

The function demand of articulation refers to those activities within the TAS that can positively affect the clarity and visibility of specific needs among technology users (van Alphen 2008:166).

There exists contradictory information whether Norway is in need of more renewable energy or not. However, in the agreement of the bilateral green certificate system there is stated that Norway is to contribute with 13,2 TWh by the year of 2020. Norway's electricity system is built up of hydropower and this seems to influence the perception of energy companies. The TGCs are the visibility for the need for more renewable energy. They believe the goal of 13,2 TWh will be met mostly through hydropower and marginally by wind power.

Need for implementation

The growth of a TAS is dependent on the exiting incentives for firms entering. Regulatory environments, visions and growth potential play an important role. The climate target in Norway is to reduce greenhouse gas emission by 30% by 2020 (UN- FCCC). There have been presented different measures to reach this target where the explicit measures are stated in the White paper 34 (Ministry of Climate and Environment, 2006-2007). It is mentioned that Norway is to produce more RES-E but not explicitly that it should come from wind power.

When I asked my interviewees about their thoughts of implementation of wind power in Norway DNC answered;

> (…) it is important to diversify the electricity sector. Norway is not self-sufficient all year round when it comes to electricity. Some periods we have an excess of electricity while in some periods we need to import electricity and that electricity is usually imported from Europe and is fossil-based (DNC, personal communication 03.12.2013).

Another respondent expressed a concern with policy makers not providing sufficient incentives for wind power implementation;

> (…) in a consultation round before the legislation of the bilateral green certificate system, we requested grid expansion. Ole Borten Moe[18] This was not done. We feel we have to operate under unfair conditions when we are obliged to produce more RES-Es (LNC, personal communication 02.12.2013)

This regulatory vision plays a central part for the expected need to implementing wind power. The TGCs are also part of influencing this function strongly by creating an incentive for firms to enter the wind power market. The design of the TGC is strongly influencing what type of technology a firm is invests in. In Norway, hydropower is the renewable energy source companies mainly invest in. However, policy is not the only thing influencing this function.

[18] The former minister of the MoPE before the change of government. [https://www.stortinget.no/no/Representanter-og-komiteer/Representantene/Representantfordeling/Representant/?perid=OBM] [Retrieved 19.04.2014]

Many actors influence the perception of what RES-E is desirable to implement. In a report in from Østfold Research in 2012, they made a comparative study measuring all the renewables in Norway, focusing on energy indicators. Energy indicators can be thought of as several indicators for extraction and delivery of an energy product (e.g. electricity, transport fuel, etc.). Such indicators main objective, is to give information about the energy efficiency of the needed extraction and transforming processes throughout the value chain related to the delivered energy product (Raadal et. al 2012:1) They found out that hydropower achieves the best energy performance in comparison to the input of energy for building the plant and produce the electricity. Wind power achieves the second best performance (Raadal et al. 2012:57). Trade organizations and other interest organizations are also important actors to promote the need for more wind power in Norway. They also influence the perception of the technology.

The government has stated that there is a need for more RES-Es. The design of the TGCs and the lack of strong actors influencing to which degree wind power is desirable, leads to path-dependent actions and the actors keep on investing in hydropower.

6.1.3 Market formation

In order to understand in which order a market takes form, one needs to analyze both the actual market development and what drives the market (Bergek et a. 2008:416). First one needs to assess what phase the market is in. In Norway the wind power market can be thought of as a bridging market. The TGCs are creating a market but the market is not considered profitable for wind power by the investors in Norway. Mainly limited companies are investing in wind power in Norway. They emphasize the slow concession process and unfavorable taxes (in comparison to Sweden), as barriers for a larger market to grow in wind power in Norway.

Phase of market

Late 1990s governmental policy targets were introduced to increase use of RES-E and energy efficiency (Blindheim 2013:337). For the first time, the Norwegian government adopted a

long-term scheme in 1999 where 3 TWh onshore wind power target should be reached by 2010. By 2010 the target was not met and only 1 TWh was produced from onshore wind power (Blindheim 2013:337). From 1998 to 2004 a subsidy for projects selling wind power domestically was implemented (Buen 2006:3892). The subsidy was given by Enova SF, aiming to stimulate wind power to secure energy supply (Buen 2006:3892).

The TGC came into operation in 2012 and has helped to boost the wind power market but there is not explicit policy directing investments towards wind power. Wind power is considered a relatively new type of renewable energy source in the Norwegian electricity system (vindportalen, no date). By the end year 2011 wind power was generating 1293 GWh[19] (NVE, 2011). At the end year of 2012, after the implementation of the TGC, electricity from wind power measured to 1556 GWh. The potential for more wind power is estimated to be around 12 TWh (FNI, 2010). To achieve this potential, many factors are influencing the decision to enter the market thus contributing to form market.

The concession process

The concession process is regulation how the wind power market will expand. NVE, together with Ministry of Petroleum and Energy, are influencing which projects get concessions. My respondent DNC stated the limited amount of concession where slowing down the diffusion process of wind power "the market needs many concessions, in this way one can investigate which projects are acceptable to implement when it comes to local acceptance and intervention with the nature" (DNC, personal communication 03.12.13),

The NVE, on behalf of the MoPE, hands out a concession which is a contractual right to operate a wind power plant. In Norway, municipalities are the decision-making authority for a wind farm that generates less than 1000 volts. The municipality should cater for wind power in its master plans. If this is not done accordingly, the MoPE can overrule the decision of the municipality (Stockholm Environment Institute, 2013:10). The government wish to regulate and control the activities for the benefits of society in alignment with the energy act (1990)[20]. A power plant owner or a power producer needs to apply for license according to the energy act, if the plant generates over 1000 volts. The license equals a permission to build

[19] MWh (megawatt-hour)=1,000 kWh, 1 GWh (gigawatt hour)=1,000,000 kWh, 1 TWh (terawatt-hour)=1,000,000,000 kWh [Vattenfall, no date] [http://www.vattenfall.com/e-learning/ordlista.htm]
[20] [http://lovdata.no/dokument/NL/lov/1990-06-29-50]

a power plant and operate it for 25 year. The license is not an obligation and does not imply that a power plant is built or a project is realized at the first place (NORWEA, Energi Norge, no date)[21]. Below the decision making institutions in Norway is depicted.

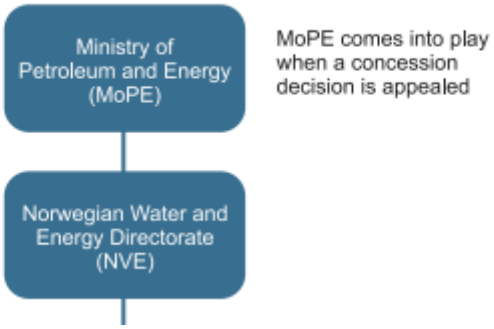

Figure 7 Decision-making bodies in Norway. (Source: Stockholm Environmental Institute, 2013).

The licensing process is done thoroughly from a filed project to receiving a concession. NVE has to follow concerning laws and regulations but they wish to complete the process as quickly as possible. Complex impact assessments, more specifically grid connection, often bring challenges to the licensing process. Negative and positive aspects with constructing a wind power plant give the basis for the decision of handing out a concession. The applicant has to cover all costs for the concession process even if the applicant receives a rejection. Expenses for the licensing process to a project that wants to generate electricity from 50 MW to 100 MW, lies somewhere between five and ten million Norwegian Kronor (NORWEA/Energi Norge, no date).

I asked an informant what they thought of the concession process;

NVE We believe the lead-time process is way too long from filed application to final decision. First uses between two to five years, investigating a project. Then the decision is appealed. MoPE uses additional two to three years. To stimulate the market the additional investigation with the MoPE could be made more efficient. Especially now when the time is limited (refering to six years before the year 2020), DNC, personal communication 03.12.2013

[21] [http://www.vindportalen.no/vind-i-norge/konsesjonsprosessen.aspx] [Retrieved 11.02.2014]

The concession process in Norway has been evaluated were the Auditor's General Norway stated the process had a too long lead-time when it comes to wind power (ANG, 2014). The extended lead time can be a sign of NVE not having enough resources to efficiently work with concessions. To take measure for the concession process will help strengthening the institutional set-up in Norway.

Even if there is a lack of political will in wind power promotion some energy companies are willing to invest in wind power. Another aspect that meets a potential investor is the taxes.

Tax regimes

On mission from Energi Norge[22], Thema consulting group made a report about the different rules for taxation of renewable electricity generation and the effects on the distribution of investments in the bilateral green electricity certificate system (Thema Consulting 2012:5). They presented suggested measures on how to create a level playing field by reduce difference in tax burden. The results from this report showed that the time-span for decreasing depreciation on all types of power production, especially on wind power, is much shorter in Sweden than in Norway. They also pointed to lower property taxes for wind power in Sweden than in Norway. In addition, the ordinary income tax is lower in Sweden than in Norway. Thema Consulting group predicts the unequal conditions for Norway and Sweden in tax deductibility will affect the expansion and diffusion of renewable power production between the two countries. Below figure 7 is displaying the different taxes:

Taxes:	Property taxes	Ordinary income taxes
Norway	0,7%	28%
Sweden	0,2%	22%

Figure 8 Display of taxes. (Sources: Thema Consulting Group, 2012).

[22] Energy Norway is a non-profit industry organization representing about 270 companies involved in the production, distribution and trading of electricity in Norway [http://www.energinorge.no/english/][Retrieved 02.03.2014].

Thema Consulting continues to argue that the different tax systems will affect the prices of the electricity certificates but the results they gotten were ambiguous and dependent of different scenarios (Thema Consulting 2012:23). The report presents some overall societal consequences due to different framework conditions. They state that with today's framework conditions, Norwegian authorities receives lower tax revenues than with harmonized conditions linked to the actual projects that are implemented, because of fewer of the projects are implemented in Norway. Swedish authorities will receive higher tax revenues for the fact that more projects are implemented in Sweden than in Norway (Thema Consulting 2012:24).

To sum up, there is an increase in the wind power market and it seems to moving from a bridging to an early mass-market. The TGC seems to have enabled a larger wind power market. The concession process with long lead-time and unfavorable taxes in Norway, measures need to be taken to speed up diffusion of wind power and create a larger market more rapidly.

6.1.4 Resource mobilization

The demand articulation influences where resources are mobilized (Jacobbson and Bergek, 2011:50). In Norway most of the energy companies investing in wind power are old hydropower users. They have a hard time financing the large up-front investments for wind power and are dependent of co-investors that can help them with additional funding. These are hard to find but some do make it. Other investors that have long experience with hydropower seldom move their investments towards wind power. The infrastructure, more specifically the electricity grid, needs to be expanded to facilitate a larger wind power implementation.

Capital

Resource mobilization is a necessary as an input for all activities in the innovation system (van Alphen 2008:167). My respondents explained what different challenges they meet as an energy company. Large Norwegian company (LNC) explained that they are willing to invest

in wind power. They already have many possible projects they are looking into. As for today, they have no wind power plant that is operational but have received concessions for a couple of projects. I further asked what they meant was crucial for them to go through with an investment in wind power:

> Money! A thorough investigation is made before taking the decision to implement any project. To start up a wind power plant takes big expenses up front. We currently experience low electricity prices which lowers our potential incomes (LNC, personal communication 02.12.2013).

Each investor attempts to forecast future demand and supply conditions in the green certificate market. The forecast are typically associated with some degree of uncertainty (Söderholm 2008:2055). Another respondent, Different Norwegian Company (DNC) explains "(…) we decided to invest in wind power and then we realized that there was a need for external investor to help us support a project. To find these investors is not easy" (DNC, personal communication 03.12.2014).

There is a lack of finding financial resources in Norway which aggravate the potential to start up wind power. The Norwegian energy companies are usually co-operatives owned by the region or a combination of many municipalities. The owner structure complicates the will to mobilize resources in wind power. The investment process in wind power is dependent on large up-front expenses. DNC explained;

> In Norway, energy companies are usually co-operatives that are owned by several municipalities. These companies have used the energy company as a mean to fund schooling, elderly care and other institutions thus leaving the company with a negative equity. It requires large upfront financing to start up wind power and it forces energy companies to seek for external investors that help them with funding. This is not an easy task. (DNC, personal communication 03.12.2014).

In Norway, most energy companies are hydro power owners. For them being hydro plant operators aggravate their ability to adapt to becoming wind power plant investors. DNC expressed the challenge about the owner structures as follows;

> Many of the firms that are entering the wind power market started out as hydro power owners. The last year has been a sign of the mismatch in the previous owner structure and the difficulties to adapt to

> becoming a wind power plant owner. Firms have to look abroad to find co-investors to enter a wind power project (DNC, personal communication 03.12.2013).

To sum up, the large upfront investment in wind power shows there is a challenge of finding financial capital. Still there are companies able to mobilize resources. These companies are usually limited companies with shareholders putting in investments. Those companies with a different owner structure, usually energy companies that formerly have been working with hydro power, struggle more to find co-investments. The struggle with finding more investments can be a sign of them choosing to invest in the RES-E they have most experience with.

Infrastructure

Statnett has the responsibility for physically making the wind power project viable by reassuring that there will be a grid connection. Grid connections can also bring challenges which all my respondents emphasized: "(…) we put all our projects in the northern part of Norway on hold because the grid is not expected to be expanded there in the near future" (LNC, personal communication, 02.12.2013). This was also declared by another respondent; "(…) problem in Norway. The good wind sites are not always located at the "right" places" (MNC, personal communication 09.11.2013).

MoPE has stated that hydropower is competing with wind power in grid access, and that the limited accessibility needs to be considered (MoPE, 2011-2012).

To strengthen the institutional capacity there is a need to expand the grid capacity to facilitate for more feasible wind power projects. The expansion in the grid will stimulate the capacity to install more wind power but expansion in the net will not have a direct effect on wind power diffusion. Energy companies have trouble with mobilizing capital because of their organizational structure and being in need of external co-financing. These are hard to find..

6.1.5 Legitimation

This function is a matter of compliance with relevant institutions and social acceptance (van Alphen 2008:167). In Norway there exist lobby groups promoting wind power. They emphasize the need for a diversified electricity sector and security supply. Other lobby groups that seem to have stronger influence on the social acceptance in Norway emphasize the use of hydropower to reach the targets stated in the RES-E Directive (EC/2001/77). The perception that seems to dominate Norway that wind power implementation brings more harm than good.

Lobby activities

Different organizations work to promote wind power. NORWEA, Energi Norge etc. Gaining legitimacy for wind power in Norway seems to be problematic on different levels. Bellona and other NGOs are emphasizing the importance of Norway's policy goal to be carbon neutral thus engage in more wind power (www.bellona.no, no date). A challenge in the energy system is the phasing in of additional renewable energy sources which can result in bringing the prices of the TGCs down. For decades, Norway has built up its energy sector on hydro power. In the earliest stage of the formative phase, legitimation involves getting the technology as a desirable and realistic alternative to hydropower. With the creation of the bilateral green certificate system it opened up for alternative investments to hydro power but the lack of resource mobilization, hampering the market formation, wind power still struggles with gaining legitimacy. LNC meant that a problem for Norwegian energy companies was a combination of different challenges;

> The energy companies are experiencing a triple squeeze. Many of the energy companies are co-operatives where the municipalities are the owner and they are challenged with large upfront investments to implement wind power plants. On top the TGCs have been implemented and alongside the EU Directive (EC/2001/77) Norway is forced to phase in more renewables which most likely are driving the prices down, bringing low revenue to the companies (LNC, personal communication 02.12.2013).

One of the informants expressed explicitly how they understood the situation of the investment process in Norway; "It is not politically viable to build more large-scale hydropower in Norway. The alternatives that are left are small-scale hydro, bio-gas or wind power" (MNC, personal communication 09.11.2013).

In the public arena the debate has been strongly colored by the issue of wind power and its' usefulness in Norway. In 2012, the Norwegian Broadcasting Corporation broadcasted a TV programmer that was a critique on wind power deployment. They stated that the deployment of wind power would have no effect on combating climate challenges (Kulturverk, 19.11.2012)[23]. What seems to be consistently repeated in the public debate is the big nature intervention that wind power implementation causes, cannot weigh up for the electricity generated, and in addition not have any effect on reducing greenhouse gas emissions. Different public opinions seem to be linked to what view one has on the bilateral green certificate system. Articles discussing the topic of wind power implementation in Norway often use the phrase "the internal match between Norway and Sweden". The phrase is used as a reference to emphasize the higher degree of wind power implementation in Sweden to point at different framework conditions for the two countries (se Løvland, 2013[24], tb.no, 2012[25]). This indicates that the public is part of influencing the legitimacy of wind power in Norway.

My respondents emphasize the contribution to work places and income to the local community as a positive effect of wind power deployment. In addition, the companies believe in contributing to reach the RES-E target. To promote wind power as a desirable renewable energy technology, there is a need for educational material to influence the social acceptance. It can be questioned of how much one can achieve with only educational material. The function legitimacy is strongly linked to all the other functions performance in the Norwegian TAS and this will be more explicitly elaborated in chapter

In the next section the functions of the Swedish TAS will be analyzed with the help of the same indicator in order to create a basis for a discussion on comparative differences and further policy implications.

6.2 Sweden

[23] Kulturverk magazine. [http://www.kulturverk.com/2012/11/19/et-slag-i-lufta-en-dokumentar-om-vindkraftindustrien-som-raserer-var-naturarv/] [Retrieved 11.05.2014].
[24] [http://avisenagder.no/index.php?page=vis_nyhet&NyhetID=21056] [Retrieved 03.03.2014]
[25] [http://www.tb.no/meninger/debattartikler/landskamp-og-helheten-1.6692452] [Retrieved 03.03.2014]

6.2.1 Creating Adaptive Capacity

As mentioned above, this function refers to how to strengthen organizational, human and institutional capacity. This can be done in several ways. In Sweden there exist general guidelines that Sweden should facilitate for 20 TWh electricity generated from wind power. The RES-E target and the general guidelines have enabled the process of creating capacity to encompass wind power as a technology. There are no signs of lack of knowledge, technicians or expertise on the field. Every company possesses the knowledge needed or else they take use of external consultancy. Trade organizations and interest organizations present educational material. "Network for wind power usage" (nb. My own translation) provides education, research and important material concerning wind power.

National policy for wind power

The oil crises in 1970 lead to a promotion of using renewable energy source with the wish to reduce the dependence of imported oil. Wind power was brought up on the political agenda already in 1975 in Sweden (Åstrand and Neij 2006:279). From the 70s to the 80s governmental measures were limited to research, development and demonstration (RD&D) (Åstrand and Neij 2006:278). In 1980 the debate concerned the nuclear power. A Swedish nuclear referendum in 1980 proposed suggestions for the future of nuclear power and was the start to policies concerning renewable power in case of phasing out nuclear power. The long-term proposal aimed at phasing out nuclear power by the year 2010[26] (Åstrand and Neij 2006:278).

The Swedish legal system has never presented a legally binding national or regional plan for wind power expansion. Still there exist general guidelines for the establishment of wind power. Ministry of Enterprise, Energy and Communications presented in Government bill 2008/09:163 a proposal for national planning for wind power. They suggested that Sweden should plan for 30 TWh (20 TWh onshore, 10 TWh off shore) in the physical planning by the year 2020 (MEEC, 2008).

[26] Government bill 2009/10:172 stated that the law was to be changed.

The National board of housing, building and planning has been responsible together with the Swedish Energy Agency to manage and deal with issues regarding physical planning for wind power plant establishment. The authorities have contributed to create adaptive capacity in Sweden in the sense of trying to focus of physical planning. It is expected that Sweden is to produce 20 TWh onshore and 10 TWh off shore from wind power.

Capacity of people and organizations

The respondents in Sweden had quite similar approach to the wind power investment process. When I asked one respondent what part of the process they in their company managed by themselves MSC told me;

> First and foremost, we are working with finding new projects and new potential sites for wind power plants. We deal with strategy, finance, budgets. Our company also provides services and maintenance of turbines. To the concession process we use consultants (MSC, personal communication 12.12.2013)

Another respondent told me they had a kind of "slimmed" organizational set-up. They were very few people in that company and where highly dependent on consultants. LSC explained;

> We are dependent on owning the project. Some of us do analysis of the field, another one is project manager following up each step in the project (…) in some phases of the project we need external expertise (…) here we need analysis of wind, there we need lawyers. We get the help we need externally (LSC, personal communication 05.02.2014).

This shows that there is a lot of outsourced expertise on the field. Companies seem to have easy access to these consultancy activities.

Educational material

Vindforsk is a research program, financed by SAE, that woks with actively share knowledge around wind power and wind power related questions. They arrange conferences yearly for the wind energy companies (svensk vindenergi, no date)[27]. "Network for usage of wind power" (NB. my translation) offers shares knowledge, offers education concerning wind power.

[27] Swedish wind energy webpage [http://www.vindkraftsbranschen.se/start/vindkraft/forskning/][Retrieved 20.04.2014]

To sum up, wind power has been on the political agenda for a couple of decades. The debate about phasing out nuclear increased the capacity for wind power implementation. Despite contradictory messages of phasing out nuclear power, the RES-E Directive has contributed to phase in more wind power to have an additional electricity source (in addition to hydropower and nuclear power). Different energy companies possess different types of knowledge. There are no signs of lacking expertise on the field of wind power. Energy companies outsource the expertise they need, relevant in the process of wind power planning. Education and educational material is easily accessible on the market.

6.2.2 Demand articulation

This function is important as it articulates the need for the specific technology. The biggest incentive in Sweden to phase in more wind power is to move away from the dependence of oil. Other expectations have surrounded the issue on phasing out nuclear power. If one expect this to happen it contributes to promote more investments wind power in the electricity system.

Need for implementation

Sweden's electricity system only consists of roughly 60 % of RES-Es. This is an overall articulation of demanding more renewables in the electricity system. The general guideline presented by MEEC of producing 30 TWh from wind power is also guiding actors to enter the wind power industry. Swedish Energy Agency (2011) presented in a report that wind power still is an unexplored renewable that has a great potential to expand (SAE, 2011:8).

Swedish wind energy presented in a report that the nuclear power plants are beginning to become outdated and that they expect the nuclear power is going to be phased out, but when is unclear (Swedish wind Energy, 2013).

In Sweden, the dependence of oil and the possible scenario of phasing out nuclear power contribute to articulate the need for more wind power. The RES-E and the general guidelines for physical wind power planning is part of directing the wind power investments.

6.2.3 Market formation

Market is formed as actors enter. The market is relatively large, and can be considered to be in the beginning of a mass-market. TGC have contributed to more investments in wind power but the size of the market is also due to earlier investment subsidies for wind power. The concession process is tricky and the investors emphasize especially the part where the concerned municipality can stop a potential wind power project. They mean the RES-E goal should be superior in all decision concerning concessions.

The phase of market

In 2003, a market-based supporting system, the TGC was implemented to promote competition between the different types of renewable energy sources and in addition to secure a pre-determined market share for renewable energy (Pettersson et al. 2010:3118). The implementation of TGC has been and still is a key policy instrument to achieve the target defined correspondingly with the RES-E Directive (Lafferty and Ruud 2008:240). In early 1990's political actions, like production and investment subsidies, lead to a development in wind power where policy energy bills contributed to the deployment of wind power in the Swedish energy system. As a result of these political actions the wind power production increased by 700% over the time period 1994-2002 (Söderholm et al., 2007:369). By the end of year 2013, electricity generated from wind power was estimated to 9,1 TWh (SEA, 2012). The installed effects were around 4500 MW.

One respondent told me about their view of where to invest with the establishment of the bilateral green certificate system. DSC stated;

(…) as soon as we knew that the agreement was going to come into operation we changed gear. We quickly identified partners to work with in Norway. It is important for us they have access to local conditions through a local partner (concession process, politics etc.). We wish to expand in Norway but is not that easy (…) and we

are waiting for OED to give their go. We believe we can enter the Norwegian market by 2016 (DSC, personal communication 28.03.2014).

The phase of the Swedish market can be understood as beginning to mass-market. There are relatively many actors on the market and is expected to grow until the end of the TGCs which is in 2035. Some private companies can even consider to enter the Norwegian market in the nearest future.

The concession process

In Sweden, the concession process differs to some extent to the one in Norway. The wind turbine operator initiates the concession process. The size of the plant and the numbers of the plants or if they are constructed on shore or offshore determines whether it is the concerned municipality, the County Administrative Board (CAB) or the Swedish Environmental Court that revise the project and hand out the concessions. Offshore wind power plants are investigated by the Swedish environmental court (CAB Västra Götalandslän, no date)[28].

Large wind farms require a permit according to the Swedish Environmental Code, granted by the County Environmental Appeal Delegation (CEAD) of the County. The CEAD is responsible for the handing out concessions when an investor applies for; a project that consists of two or more wind power plants and when the wind turbines reach 150 meters or higher. The same goes for wind power projects that are going to consist of seven or more power plants that reach the height of 120 meters. Any project not fulfilling the aforementioned criteria is treated by the municipality. The municipality also hands out the building permission that is needed. The municipalities have a major influence over wind power development either as the final decision maker or as the consultative body. It also has the right to veto the development of any large wind power farms in its own area

A decision by the CEAD can be appealed to the Land and Environment Court (LEC). A decision by the LEC can be appealed to the Land and Environment Court of Appeal (LECA) but can only be done if the LECA has granted leave for such an appeal (Stockholm Environment Institute, 2013:15).Below the decision-making bodies in Sweden are depicted.

[28] [http://www.lansstyrelsen.se/vastragotaland/Sv/samhallsplanering-och-kulturmiljo/energi/Vindkraft/Tillstandsprocessen/Pages/Tillstand-Vindkraft.aspx]

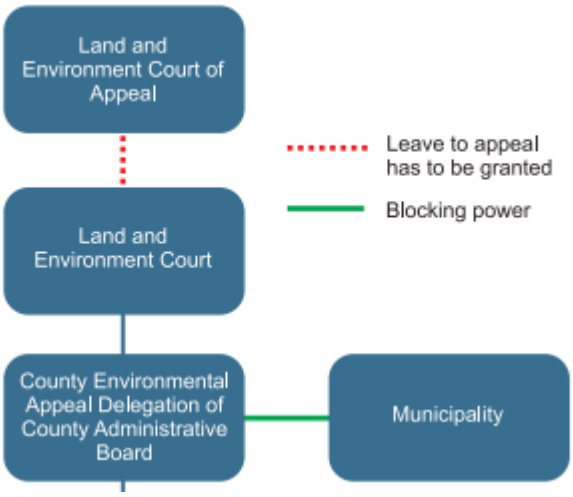

Figure 9 Decision-making bodies in the concession process in Sweden. (Source: Stockholm Environment Institute, 2013).

The licensing process is done thoroughly to consider environmental effect contra public interests in keeping with the Swedish Environmental Code (MTE, 2000:61). When a concession is handed out conditions follow regarding noise and how the plant casts shadows. To file an application to receive a concession for a wind power plant differs from other types of renewables. The CAB or the Swedish Environmental Court can only hand out a concession if the project has been pre-approved by the municipality. Further down in the process of getting a licensing for a wind power plant energy companies hold formal consultations and talk with the local community.

Respondent MSC stated;

> First of all the concession process is long and time consuming (…) we think the national plan for renewables should weigh heavier than the municipal veto. We have lost a couple of project because of too much resistance in the concerning municipality. They do not have the best arguments for using their veto (MSC, personal communication 12.12.2013)

This is a risk for investors knowing they can lose the projects if the municipality decides to use their veto and dismiss a wind power plant project. Companies applies for many project because some will not be feasible, some will get dismissed because of bad conditions concerning wind speed etc. The project must be very good for an investor to enter the market.

Tax regimes

I Sweden, all power generation is charged with different types of taxes. Wind power is charged with a property tax. As shown in figure 7 above, the tax rates differ between Norway and Sweden. In 2007, property tax on wind turbines was lowered from 0,5 to 0,2% (Svensk Energi, no date)[29]. Taxes for other power generation equipment remained the same.

One of my respondents mentioned briefly; "(…)one of the obvious reasons we keep investing in Sweden is the tax differences between the two countries (DSC, personal communication 28.03.2014). The taxes play a part when the Swedish energy companies are deciding on where to contribute to the market formation. They do not rule out revising tax differences.

To sum up, the market is large and increasing in Sweden. TGC and earlier investment subsidies have contributed to the size and phase of the wind power market. Revising tax differences is part of the process before taking the decision to enter the market. The concession process and especially the part with the municipalities veto, is hampering investments.

6.2.4 Resource mobilization

Human and financial resources must be mobilized in order for the TAS to grow. In Sweden the owner structure of the company is closely couple with the ability to mobilize resources. TGC are helping to direct investments in wind power but depending on owner structure where

[29] Svensk energi webpage. [http://www.svenskenergi.se/Elfakta/Elpriser-och-skatter/Skatter-och-avgifter-pa-produktion/] [Retrieved 22.05.2014]

some are in need of external financial co-investors. The grid is underdeveloped in the northern region in Sweden whereas in the southern parts the gird is better facilitated.

Capital

The respondent differed when it came to how much financial resource they were able to mobilize. Respondent MSC is a co-operative and wholly owned by a region. They describe their situation to me as follows;

> We started to build wind power in the 1990s. Large-scale wind power investments started in 2009. The TGC were in place and the prices were relatively high. The situation has changed. Those projects we invested in a couple of years ago where based on those days revenues. Today, for these projects, the revenue has decreased by somewhere between 30 and 40 %.(…). The company has no intentions of investing in more wind power for now. (MSC, personal communication 12.12.2013).

The picture describe above shows to the importance for wind power companies to have excess financial resources to be able to invest in more wind power project. If these resources are not generated the company is forced to rely on bank loans. The situation for MSC differed from one of my other respondents. LSC stated; "we are part of a large corporate. We have all the capital we need. Money is not an issue for us" (LSC, personal communication 05.02.2014).

It seems that private companies, in comparison to co-operatives, have easier to mobilize resource. The private companies are less hesitant to invest whereas the co-operatives are stronger dependent on bringing in good revenues for earlier investments.

Infrastructure

The expected increase of wind power implementation puts a pressure on Swedish National Grid to expand the grid. In 2008, they raised concerned of with Swedish wind power reaching 10 TWh. Swedish national grid states that they are prepared to do large investments to expand the grid to facilitate (Swedish National grid, 2008:4). Another concern was more about the conflict of interest where on one hand you have those who emphasize the importance of phase in more renewables to move away from fossil, on the other hand you have the local opposition not wanting intervention in their local environment (Swedish National grid, 2008:4).

None of my respondents stated that there was a problem with the grid capacity. They mentioned it was more a political issue concerning if grid expansion would take place or not. One respondent said: in south Sweden the grid is relatively well expanded.

To sum up, the revenue and ability to mobilize financial resources are strongly linked to owner structure of the company. The grid is fairly well functioning and Swedish National grid is focusing on making sure they can cope with potential expansion in the future, but states that it is a political issue.

6.2.5 Legitimation

As aforementioned this function deals with the social acceptance to wind power. Legitimacy is not given it is something that is formed through process where actors' consciously act in such way (e.g. organizations and individuals choosing to invest in wind power because they believe it is the right choice to do so) that it has an effect legitimize the technology (Jacobsson and Bergek 2011:47).

Lobby activities

All my respondents stated that the reason they invest in wind power is because of the phasing out of nuclear power. Other important NGOs are more precautious about emphasizing wind power as means for phasing out nuclear power, but more as a mean for providing additional electricity security, besides hydropower and nuclear power.

In Sweden there are different lobby activities. Swedish environmental protection agency is providing information on anything from the effects on the society, nature, birds etc. They are part of providing information so the public can get the information they are demanding.

DSC mentioned that there are some lobbying activities out spreading “false” information. “This false information usually states that wind energy companies receive large subsidies, that nuclear power is cheap” (DSC, personal communication 28.03.2014).

To sum up, there exist different lobby activities in Sweden but major NGOs and organization seem to influence positively on wind power as a technology.

7 Discussion

Sweden and Norway have a shared market where the bilateral green certificate system has established the playground rules. The connection between the TAS and the functions shows how different frameworks conditions and inducement and blocking mechanisms are generating a higher share of wind power investment in Sweden than in Norway.

The RES-E Directive puts pressure on both countries to phase in more renewables in their electricity systems. The TGCs have been implemented to induce the potential to invest in wind power. The potential is not explored in Norway. There seems to be worse framework conditions for wind power investors in Norway than in Sweden. Poorly expanded grid, higher taxes, a slow concession process and a hard time to mobilize resources are indicators that appeared in the analysis. The bilateral green certificate market seems to be creating a profitable market for wind power investors in Sweden but not in Norway. In Sweden the grid is better expanded, physical planning is facilitating wind power expansion, and better taxes can make good revenues for wind power companies in Sweden. To level out the playing field, policy makers can address these aforementioned differences. Taking measure to even out these differences can open up the possibility for Swedish wind energy companies to explore the Norwegian market.

There are many different linkages to connect different blocking mechanisms in the Norwegian TAS for wind power. It is not always an easy task to disentangle the different functions, thus the indicators have been working as a "research" lenses. Both Norway and Sweden have both created adaptive capacity for being able to implement wind power. Sweden had earlier an incentive to phase in more RES-Es as a way to move away from oil dependence. Norway has already an electricity system built up of RES-Es. The demand articulation is lacking in Norway whereas it specifically articulated in the Swedish guidelines for physical planning of wind power.

The function *demand articulation* is strongly coupled to the legitimation. In Norway the debate concerns of whether there is a need for Norway to phase in more renewables. Earlier paths of hydropower exploitation make investors to keep on investing in hydropower.

The bilateral green certificate system creates a more desirable market for hydropower in Norway. In Sweden hydropower is not really challenging wind power as an energy source.

In Norway the energy companies started investing in hydropower. These energy companies have trouble in adapting to wind power in such way that they have hard times mobilizing resources in wind power. Co-operatives in Sweden experience the same. Limited companies have a better chance of making large up front investments that are need in Sweden.

Sweden is in higher degree in need of RES-E and earlier demand articulation has directed investments in wind power at an earlier stage. The need for implementation has also brought legitimation for wind power deployment in Sweden. The demand articulation is strongly linked to legitimacy. TGCs are designed to support the most efficient RETs. The data indicates that the bilateral green certificate market as an institution creates wind power investments as a profitable market in Sweden but not in Norway. The strong disagreements of whether Norway is in need of additional RES-Es and if that should be wind power is blocking the demand articulation, market formation and resource mobilization. Strong direct political regulations will be the only thing overcoming the path dependency of hydropower. A future research suggestion is to get a better understanding of the weaknesses in the Norwegian wind power TAS which could be achieved through a more thorough analysis using all the functions.

References

Agterbosch, S. and Breukers, S. (2008). "Socio-political embedding of onshore wind power in the Netherlands and North Rhine-Westphalia" in *Technology analysis and strategic management vol. 20(5): 633-648.*

Alphen, K. et al. (2008) "Renewable energy technologies in the Maldives – realizing the potential" *in Renewable and Sustainable Energy Reviews 12 (2008): 162-180.*

Bellona (2013). *Vindkraft – en nödvändig og sentral klimalösning*. [http://bellona.no/assets/Vindkraft-en-n%C3%B8dvendig-og-sentral-klimal%C3%B8sning.pdf] [Retrieved 11.03.2014]

Bergek.A. (2012). "Ambiguities and challenges in the functions approach to TIS analysis: a critical literature review". IST 2012 - International Conference on Sustainability Transitions, 29-31 August, Copenhagen, Denmark, 2012.

Bergek, A., Jacobsson, S. (2010) "Are tradable green certificates a cost-efficient policy driving technical change or a rent-generating machine? Lessons from Sweden 2003 – 2008" *in Energy Policy, 38 (2010) 1255:1271*.

Bergek, A., Jacobsson, S, Sandén, B. (2008). "'Legitimation' and 'development of positive externalities': two key processes in the formation phase of technological innovation systems" in *Technology analysis and strategic management, vol. 20 (5): 575:592.*

Bergek, A., Jacobsson, S., Carlsson, B., Lindmark, S. and Rickne, A. (2008). "Analyzing the functional dynamics of technological innovation systems: A scheme of analysis." *in Research Policy, 37(3): 407-429.*

Blindheim, Bernt (2013). "Implementation of wind power in the Norwegian market; the reason why some of the best wind resources in Europe were not utilised by 2010" in *Energy Policy 58 (2013): 337-346.*

Bradshaw, M., Stratford, E.. (2010). "Qualitative research design and rigour" in *Qualitative research methods in human geography,* Hay, Iain (Ed.). Canada: Oxford university press.

Buan, I. F., Eikeland, P O., Inderberg, T H. (2010). "Rammebetingelser for utbygging av fornybar energi i Norge, Sverige og Skottland – sammenligning av faktorer som motiverer og modererer investeringer", Fridtjof Nansens Institutt, Report 6/2010. (in Norwegian).

Carlsson, B., Stankiewicz, R., (1991). "On the nature, function, and composition of technological systems" in *Journal of Evolutionary Economics 1 (1991): 93-118.*

Carlsson, B. et al. (2002). "Innovation system: analytical and methodological issues" *in Research Policy 31 (2002): 233-245*.

David, P.A. (1985) "Clio and the economics of QWERTY" in *American Economic Review, Vol. 75(2): 332-337).*

Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 in the promotion of electricity produced from renewable energy sources in the internal electricity market, Brussels.

Dosi, G. (1982). "Technological paradigms and technological trajectories" *in Reserach Policy 11 (1982): 147-162.*

Dunn, Kevin (2010). "'Doing' qualitative research in human geography" in *Qualitative research methods in human geography,* Hay, Iain (Ed.). Canada: Oxford university press.

Ekonomifakta (2014). *Prisutveckling elcertifikat* [http://www.ekonomifakta.se/sv/Fakta/Energi/Styrmedel/Elcertifikat/?from14309=2006&to14309=2014].

Elsertifikatloven 24.06.2011, *Lovdata: Vilka förnybara källor ingår i avtalen.* Olje- og energidepartementet [http://lovdata.no/dokument/NL/lov/2011-06-24-39#KAPITTEL_2] [Retrieved 14.03.2014]

European Commission, 2011. "Green public procurement – Electricity: Technical background Report [http://ec.europa.eu/environment/gpp/pdf/tbr/electricity_tbr.pdf]

European Commission, April 12th, 2013 [http://ec.europa.eu/competition/state_aid/modernisation/centeno-lopez_en.pdf]

European Union, 2011.04.01. *Summaries of EU legislation.* [http://europa.eu/legislation_summaries/energy/european_energy_policy/en0025_en.htm] [Retrieved 21.12.2013]

Fagerberg, Jan, Mowery, David C., Verspagen, Bert (Eds.) (2009) *Innovation, path dependency, and innovation: The Norwegian case*, New York: Oxford University press.

Fagerberg, Jan (2005). "Innovation: A guide to the literature" in *The Oxford Handbook of Innovation,* Fagerberg, Jan, Mowery, David C., Nelson, Richard (ed.). New York: Oxford University Press.

Førsund, Finn R. et al. (2008) "Phasing in wind-power in Norway: Network congestion and crowding-out of hydropower" *in Energy Policy 36 (2008): 3514-3520.*

Garud, R., Karnoe, P., (2003). "Bricolage versus breakthrough: distributed and embedded agency *in technology entrepreneurship" in Research Policy Vol. 32 (2): 277-300.*

Hall, Bronwyn H. (2005). "Innovation and diffusion" in *The Oxford Handbook of Innovation,* Fagerberg, Jan, Mowery, David C., Nelson, Richard (Eds.). New York: Oxford University Press.

Hanson, Jens, Kasa, Sjur, Wicken, Olav. (Eds.) (2011) *Energirikdommens Paradokser*, Oslo: Universitetsforlaget (in Norwegian).

Hatt, Anna-Karin, 2011. Minister for Ministry of Enterprise, Energy and Communications, The Swedish Government, [http://www.regeringen.se/sb/d/14269/a/186705]

Hay, Iain (2010). *Qualitative Research methods in human geography*. Canada: Oxford University press.

Hekkert, M.P., Negro, S.O. (2009). Functions of innovation systems as a framework to understand sustainable technologicial change: Empirical evidence for earlier claims *in Technological Forecasting and Social Change, vol. 76(2009): 584-594.*

Hillman, K. et al.(2011) "Fostering sustainable technologies: a framework for analysing the governance of innovation systems" in *Science and Public Policy 38 vol.5 (2011): 403-415.*

IEA (2013). *The framework: energy policy and climate change - Sweden. Excert.* [http://www.iea.org/textbase/nppdf/free/2013/sweden2013_excerpt.pdf] [Retreived 12.03.2014]

IEA Norway (2011). *Energy policies of IEA Countries – Norway. Review* [https://www.iea.org/publications/freepublications/publication/Norway2011_web.pdf] [Retrieved 12.03.2014]

IEA (2013), *Key World Energy Statistics 2013*, International Energy Agency.

IPCC (2000). Methodological and Technological issues in Technology transfer – a special report of IPCC working group III. Camebridge University Press: USA.

Jacobsson, S., Bergek, A. (2011). "Innovation system analyses and sustainability transitions: contributions and suggestions for research" *in Environmental Innovation and Societal Transitions 1 (2011): 41-57.*

Jacobsson, S., Johnson A., (2000). ”The diffusion of renewable energy technology: an analytical framework and key issues for research” *in Energy Policy 28 (2000): 625-640.*

Jacobsson, Staffan and Bergek, Anna (2004) “Transforming the energy sector: the evolution of technological systems in renewable energy technology” *in Industrial and Corporate Change Vol. 13 (5): 815-849.*

Kline, David M., Vimmerstedt, L., Benioff, R. (2003). *Clean energy technology transfer: a review of programs under the UNFCCC.* National Renewable Energy Laboratory, Golden, Colorado USA.

Knudsen, J., Larsen, O. M., Ruud. A., (2008) “Norway: trying to maintain maximal RES-E in a petroleum-driven economy” in *Promoting sustainable electricity in Europe*, Lafferty, William M, Ruud, Audun (Eds.). UK: MPG Books Ltd.

Lafferty, William M., Ruud, Audun (2008). *Promoting sustainable electricity in Europe.* UK: MPG Books Ltd.

Linnerud, K., Holden, E. (2013). *Ny vannkraft innen 2020 – potensiale og barrierer*. Høgskulen i Sogn og Fjordane.

Markard, J., Truffer, B. (2008). ”Technological innovatin systems and the multi-level perspective: towards an integrated framework” *in Research Policy 37 (2008): 596-615.*

Ministry of Enterprise, Energy and Communications (2013) *Common Swedish Norwegian certificate market for renewable electricity,* Report: Sweden Workshop on Review Environmental State Aid Guidelines 12 April 2013.
[http://ec.europa.eu/competition/state_aid/modernisation/centeno-lopez_en.pdf] [Retrieved 14.04.2014]

Ministry of Petroleum and Energy.(2003-2004). St.meld. 18 (2003-2004). *Om forsyningssikkerhet for ström mv.* Oslo: Ministry of Petroleum and Energy [http://www.regjeringen.no/nb/dep/oed/dok/regpubl/stmeld/20032004/Stmeld-nr-18-2003-2004-/2.html?id=197847][Retreieved 23.03.2014]

Ministry of Petroleum and Energy (2008). *Faktahefte: Kraftsystemet.* Norwegian Government.
[http://www.regjeringen.no/upload/OED/pdf%20filer/Faktaheftet/EVfakta08/Evfakta08_kap07_no.pdf] [Retrieved 22.03.2014]

Mohorst, P.E. (2000). “The development of a green certificate market” in *Energy Policy 28 (2000): 1085-1094.*

Nord Pool Spot.
[http://www.nordpoolspot.com/How-does-it-work/] [Retrieved: 24.04.2014]

NORWEA, Energi Norge, (2014). *Konsesjonsprosessen*
[http://www.vindportalen.no/vind-i-norge/konsesjonsprosessen.aspx] [Retrieved 11.02.2014]

Norwegian Environmental Agency (2010). *Klimakur 2020. Tiltak og virkemidler for å nå norske klimamål mot 2020* Report: TA-2590. 312 pp. (in Norwegian).
[http://miljodirektoratet.no/old/klif/publikasjoner/2590/ta2590.pdf] [Retrieved 19.04.2014]

NVE (2011).*Energi i Norge 2011.* Fact sheet.
[http://www.nve.no/Global/Energi/Analyser/Energi%20i%20Norge%20folder/FOLDN2012.pdf] [Retrieved 20.04.2014]

NVE (2012). *Ny kraft: Endelige tillatelser og utbygging*, 4 kvartal 2012..
[http://www.nve.no/Global/Energi/Q412_ny_energi_tillatelser_og_utbygging.pdf] [Retrieved 08.04.2014]

The Office of Auditor’s general Norway.

[http://www.riksrevisjonen.no/Presserom/Pressemeldinger/Sider/Fornybar.aspx] [Retrieved 14.04.2014]

Official Norwegian Report 2012:9, *Energiutredning – verdiskaping, forsyningssikkerhet og miljo*.Ministry of Petroleum and Energy, Norwegian Government [http://www.regjeringen.no/nb/dep/oed/dok/NOU-er/2012/nou-2012-9/12/5.html?id=675568] [Retrieved 21.03.2014].

Patton, Michael (2002). *Qualitative Evaluation and Research Methods*. Beverly Hills: Sage.

Pettersson, Maria, Ek, Kristina, Söderholm, Kristina, Söderholm, Patrik (2010) "Wind power planning and permitting: Comparative perspectives from the Nordic countries" in *Renewable and Sustainable Energy Reviews, Vol. 14 (2010) 3116:3123.*

Punch, Keith F. (2005) *Introduction to social research – quantitative and qualitative approaches*. London: Sage

Raadal, H.L., Modal, I.S., Bakken, T.H., (2012) *Energy indicators for electricity production - Comparing technologies and the nature of the indicators Energy Payback Ratio (EPR), Net Energy Ratio (NER) and Cumulative Energy Demand (CED)* Ostfold Research report, OR: 09.12 [http://ostfoldforskning.no/uploads/dokumenter/publikasjoner/684.pdf] [Retrieved 20.04.2014].

SEA/NVE (2012) *The Swedish-Norwegian Electricity Certificate market*. Annual report. [file:///C:/Documents%20and%20Settings/Anne/My%20Documents/Downloads/The%20Swedish-Norwegian%20electricity%20certificate%20market.PDF] [Retrieved 12.02.2014]

Smith, Keith (2011) "Den vansklige transformasjonen" in *Energirikdommens Paradokser,* Hanson, Jens, Kasa, Sjur, Wicken, Olav. (Eds.). Oslo: Universitetsforlaget (in Norwegian).

SOU 2001:77 *Handel med elcertifikat – ett nytt sätt att främja el från förnybara energikällor.* Swedish government. [http://www.regeringen.se/content/1/c4/22/16/f784596e.pdf].[Retrieved 29.03.2014]

Suurs, R. et al. (2010) "Understanding the formative stage of technological innovation system development: The case of natural gas as an automotive fuel" *in Energy Policy 38 (2010) 419-431*.

Swedish Energy Agency (2013) *Energimyndighetens årsredovisning – 2013.* ER:2014:1 [http://www.energimyndigheten.se/Global/Om%20oss/Energimyndighetens_Arsredovisning_2013.pdf] [Retrieved 09.04.2014]

Swedish Energy Agency 2012, *Energy in Sweden*. [http://www.energimyndigheten.se/Global/Engelska/Facts%20and%20figures/Energy_ in_sweden_2012.pdf] [Retrieved 02.03.2014]

Swedish Energy Agency (2013). *Energiläget 2013*. [https://energimyndigheten.a-w2m.se/Home.mvc?ResourceId=2785] [Retrieved 06.04.2014]

Swedish Energy Agency (2013). Facts and Figures. [http://www.energimyndigheten.se/sv/Statistik/Overgripande-rapporter/] [Retrieved 11.02.2014]

Swedish Energy Agency (2011). *Vindkraftsstatistik 2011.* Report: ES:2012:02. [http://www.energimyndigheten.se/PageFiles/110/Vindkraftsstatistik-2011.pdf] [Retrieved 24.04.2014].

Swedish Government, (2005). Government bill 2005/06:154, Ministry of the Environment. (in Swedish).

[http://www.regeringen.se/content/1/c6/06/07/70/d223a994.pdf] [Retrieved 11.02.2014]
Swedish Government (2008) Government bill 2008/09:163. Ministry of Enterprise, Energy and Communication. (in Swedish). [http://www.regeringen.se/content/1/c6/12/27/85/65e0c6f1.pdf] [Retrieved 14.04.2014]
Swedish Government. (2014) *Om en gemensam Norsk-Svensk elcertifikatmarknad*. [http://www.regeringen.se/content/1/c6/15/73/80/5daa9805.pdf] [Retrieved 20.01.2014]
Swedish Government, Government bill 2009/10:172 .*Kärnkraften – förutsättningar för generationsskifte* [http://www.regeringen.se/content/1/c6/14/23/59/12af3725.pdf]
Swedish national grid (2008). *Storskalig utbyggnad av vindkraft*, report: Dnr 617/2008/AN40 [http://www.svk.se/Global/01_Om_oss/Pdf/Rapporter/%20080601_Bilaga_vindkraftrapport_2008.pdf] [Retrieved 22.05.2014]
Swedish Wind Energy (2013) *På väg mot ett förnybart elsystem – möjligheter till 2030*. [http://www.vindkraftsbranschen.se/wp-content/uploads/2013/03/P%C3%A5-v%C3%A4g-mot-ett-f%C3%B6rnybart-elsystem-m%C3%B6jligh...2.pdf] [Retrieved 20.05.2014]
Söderholm, P. (2008). "The political economy of international green certificate markets" in *Energy Policy 36 (2008): 2051-2062*.
Söderholm, Patrik., Ek, Kristina, Pettersson, Maria (2007). "Wind power development in Sweden: Global policies and local obstacles" in *Renewable and Sustainable Energy Reviews, Vol. 11 (3): 365-400*.
Thagaard, Tove (2009). *Systematikk og innlevelse: en innføring i kvalitativ metode.* Bergen: Fagbokforlaget
Unruh, Gregory C. (2000). "Understanding carbon lock-in" in *Energy Polic 28 (2000): 817-830.*
Unruh, Gregory C. (2002). "Escaping carbon lock-in" in *Energy Policy 30 (2002): 317- 32.*
Valentine, Gill (2005) "Tell me about..:using interviews as a research methodology" in *Methods in Human Geography*, Flowerdew, Robin, Martin, David (Eds.). England:Pearsons Education Limited.
Verspagen, Bart (2005). "Innovation and economic growth" in *The Oxford Handbook of Innovation*, Fagerberg, Jan, Mowery, David C., Nelson, Richard (Eds.). New York: Oxford University Press.
Westgaard, G., Fiksen, K.(2012*). Kapasitetsutfordringer for utbygging av småkraft og vindkraft – Resultater fra intervjuer med bransjen*. Forseminar PTK. Thema Consulting (in Norwegian) [http://www.energinorge.no/getfile.php/FILER/KALENDER/Foredrag%202012/PTK2012/Mandag_5._Mars/05_Kristine_Fiksen.pdf] [Retrieved 17.04.2014]
White paper 14 (2011-2012). *Vi bygger Norge – om utbygging av strømnettet*. Ministry of Petroleum and Energy: Norwegian Government. [http://www.regjeringen.no/nb/dep/oed/dok/regpubl/stmeld/2011-2012/meld-st- 14-20112012/1.html?id=673808] [Retrieved 20.04.2014]
Wizelius, Tore (2009). "Vindkraft på lantbruk". [https://www.natverketforvindbruk.se/Global/N%C3%A4ringsliv/Vindkraft%20p%C3%A5%20lantbruk%20web.pdf][Retrieved 18.02.2014]
The World Bank (2014). *CO_2 emissions (metric ton per capita)*. [http://data.worldbank.org/indicator/EN.ATM.CO2E.PC][Retrieved 04.05.2014]

Yin, Robert K. (2009). Case study research. UK: Sage publications Inc.

Yin, Robert K. (2011). *Qualitative research from start to finish*. New York: The Guilford Press

Åstrand, K. and Neij, L. (2006) "An assessment of governmental wind power programmes in Sweden – using a systems approach" *in Energy Policy 34 (2006): 277-296*.

Appendix 1 – Informed consent

Forespørsel om deltakelse i forskningsprosjektet

"**Where ever the wind blows - a study on policy motives and the analysis of the inducement/blocking mechanisms in the wind power installation process in the joint Norwegian-Swedish energy market"**

"Bakgrunn og formal
Detta är ett masterarbete som ska se närmare på investering och uppbyggnad av vindkraft i energisamarbetet Norge och Sverige har. Genom dem gröna certifikaten vill den norska och svenska regeringarna stimulera uppbyggnaden av förnybara energikällor. Vindkraftsutbyggningen i Sverige och Norge ser olika ut och det är intressant att forska på varför vindkraften är vesentligt större i Sverige än i Norge. Energisystemen i respektive land ser olika ut och mina huvudfrågor är:

Varför skiljer sig vindkraftsutbyggningen länder emellan? Vilka faktorer främjar versus hindrar utbyggnad av vindkraft i respektive land?

Ni har blivit tillfrågade att delta i denna intervjun för att ni driver med vindkraftsuppbyggnad i Norge/ Sverige.

Hva innebærer deltakelse i studien?

Genom intervjuer kommer jag att försöka belysa vilka faktorer som är med att påverka varför ett företag beslutar sig för att satsa på vindkraft. Jag kommer även att försöka kartlägga vilka faktorer som måste till för att man beslutar att investera i Sverige istället för Norge eller omvänt. NVE och Svenska vindkraftsbranschen bistår med generell information om vilka som får tillstånd sk. Konsesioner och vilka regelverk som omfattar ett vindkraftsprojekt. I tillägg kommer jag använda mig av föreliggande litteratur om gröna certifikat och deras önskade effekt och faktiska effekt. Existerande forskning på vindkraft och runtomliggande faktorer som hindrar eller främja vindkraftsutbyggnad kommer även att användas. Alla intervjuer kommer att bli inspelade och supplerade med anteckningar.

Utvalda respondenter är vindkraftsföretag i Norge och Sverige som har fått byggnadstillstånd.

Hva skjer med informasjonen om deg?
Alle personopplysninger kommer behandlas konfidentiellt. Endast jag och mina vägledare kommer att ha tillgång på min data. Datamaterialet kommer uppbevaras på separata filer som efter avslutat masterarbete kommer att raderas. Alla företag kommer att anonymiseras och kommer inte kunna igenkännas. Prosjektet skal etter planen avsluttas 26/5 - 2014.

Frivillig deltakelse

Det er frivillig å delta i studien, og du kan når som helst trekke ditt samtykke uten å oppgi noen grunn. Dersom du trekker deg, vil alle opplysninger om deg bli anonymisert.

Dersom du ønsker å delta eller har spørsmål til studien, ta kontakt med **Ulrika Marie Eriksson** på mobil nr: 45018168 eller e-post: ulrikaer@student.sv.uio.no

Studien er meldt til Personvernombudet for forskning, Norsk samfunnsvitenskapelig datatjeneste AS.

Samtykke til deltakelse i studien

Jeg har mottatt informasjon om studien, og er villig til å delta

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(Signert av prosjektdeltaker, dato)

Appendix 2 – Interview guide

Aktuellt:

- Berätta om vem ni är och hur ert företag ser ut.
- Vilken organisationsform?
- Vilka ägare?
- Kapital/ omsättning
- Hur kom det sig att ni beslutade gå in i vindkraftsbranschen?

Investeringsprocessen

- Fanns det alternativ till vindkraft? Varför?
- Hur skapades idén?
- När tog ni beslut? Hur gick det till? Risker/ möjligheter?
- Utvärdering av investering? (skatt, certifikatpris etc)
- Vad avgjorde beslutet? (ngt annat än kalkylen?)
- Detaljer i investering?

Finansiering

- Varifrån kommer investeringskapital?
- Vad finns det för avkastningsplan?
- Flera investerare?
- Finns andra typ av resurser investering beror på (mark, befintlig utrustning etc)

Framtiden

- Expanderingsplaner?

- Prisutveckling?
- Hur tror ni certifikatpriser utvecklas?
- Vilken bild har ni av Norsk-Svensk certifikatmarknad? (på pris, ny anläggningar?)
- Vad tror ni sker efter 2020?